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“Biodiversity crisis in a changing world”

6th European Congress of Conservation Biology

August 22–26, 2022, Prague, Czech Republic

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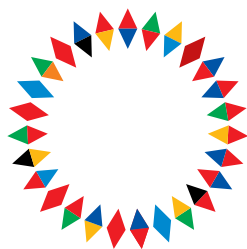
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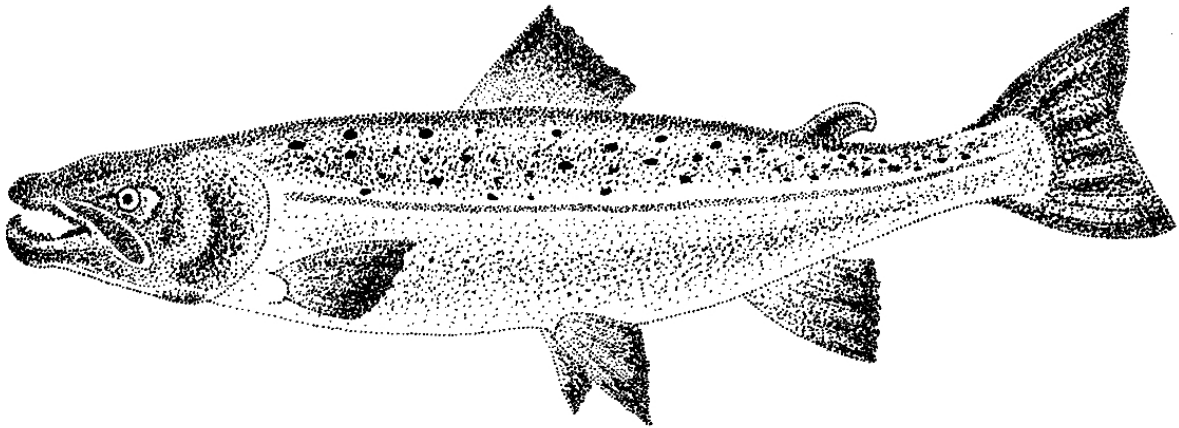
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Graphics by: Sarah Maršíková
Tyto alba

Plenary presentations



Graphics by: Sarah Maršíková
Salmo salar

The large carnivores of Europe: the challenges of conservation and coexistence.

Boitani L

The large carnivores of Europe are, with few local exceptions, increasing in number and expanding in ranges. The trend is likely to continue as increasingly large parts of Europe are being abandoned in mountains and marginal agricultural areas. Conservationists must face a shift in focus, from battling to save endangered species to managing a conservation success with extensive economic, social and ecological implications.

Diverse values and plural valuation: options and opportunities to contribute to sustainability transformations.

Kelemen E¹

¹*Essrg Nonprofit Kft., Budapest*

The IPBES Global Assessment (GA) (IPBES, 2019) called for transformative actions to halt the loss of biodiversity which, at its current unprecedented pace, is threatening with the disruption of the social-ecological systems we are living in. The GA also highlighted that the indirect drivers of change (such as population growth, unsustainable production and consumption patterns, technology development or governance deficiencies and conflicts) are underpinned by the worldviews and values society holds. The scientific interest in values and valuation and its relationship to governance and policymaking is growing rapidly, leading to the recognition that acknowledging diverse values in decision-making is the prerequisite to effectively support and manage system-wide transformations towards a more sustainable future, but at the same time needs substantial changes in our existing governance systems (Visseren-Hamakers et al. 2021). The recent IPBES Assessment on Values and Valuation, getting discussed at the IPBES Plenary 9 in July 2022, digs deep into the theory and practice of the valuation of nature and its contributions to people, and provides guidance to the scientific community, as well as to decision-makers in different sectors and scales, on how to operationalize the values of nature in decision-making. This plenary presentation will share some of the key insights of the Values Assessment, especially how the values of nature can be conceptualized, how it is possible to assess the diversity of values, and what options and opportunities are available for decision-makers to act upon the diverse values of nature.

Earth4All

Wijkman A¹

¹*Club of Rome, Stockholm*

Presentation of a report that will be launched in the summer of 2022, partly as a 50-year follow-up to the Limits to Growth. "Earth4All" is an international initiative, supported by the Club of Rome, Potsdam Institute for Climate Impact Studies, Stockholm Resilience Center and the Norwegian Business School. The purpose is to accelerate the systems-changes we need for an equitable future on a finite planet. The dominant economic model of today is destabilising societies – socially and ecologically. It is time for change.

Combining the best available science with new economic thinking, Earth4All is designed to explore and promote five transformations that can create prosperity for all within the planetary boundaries. The five turnarounds are focused on poverty, inequality, energy, food systems and empowerment of women.

A better future is possible, but we don't have much time. The next ten years must see the fastest economic transformation in history!

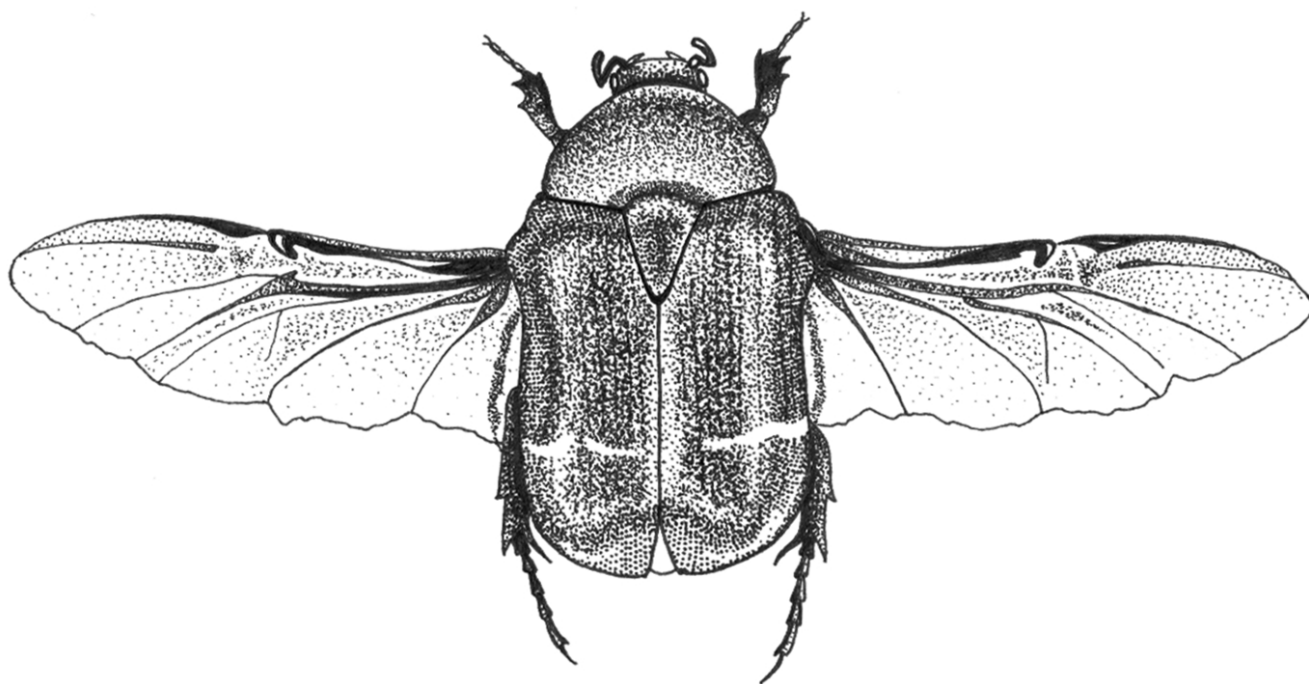
Rapid adaptation: a chance or a danger in species conservation?

Münzbergová Z¹

¹*Institute of Botany, Czech Academy of Science
Dep. Botany, Faculty of Science, Charles University*

In this talk she explored plant species abilities to adapt to changing environmental conditions, which may be both beneficial e.g. in case of helping plants to deal with changing climate as well as detrimental e.g. in species adaptations to cultivation in ex-situ collections. She also explored whether cultivation of plants in private gardens, a novel approach to ex-situ species conservation, may mitigate the problems observed in other ex-situ collections.

Abstracts of symposia



Graphics by: Sarah Maršíková
Cetonia aurata

How well does online information-seeking behavior indicate public conservation orientation? Taxonomy and personal characteristics matter

Akasaka M¹, Kubo T, Soga M

¹*Tokyo University of Agriculture and Technology, Tokyo, Japan*

Public conservation support for a species can powerfully influence the success of conservation policies and actions. To maximize the effectiveness of the limited resources available for conservation, it would be beneficial to develop a way to predict the degree of public conservation orientation. Here, we explore the utility of the frequency of accessing web content featuring particular species, a direct measure of information-seeking behavior, to predict public conservation orientation. Specifically, we tested whether pageviews of Wikipedia content featuring 100 threatened species in five taxonomic groups (mammals, birds, reptiles and amphibians, insects, and plants) is associated with public conservation orientation toward these species in Japan. Wikipedia pageviews predicted public conservation orientation for species conservation for the two most salient taxonomic groups (mammals and birds). This relationship, however, was not evident for the other three taxa. Overall, information-seeking behavior could be used as a proxy for public conservation orientation for mammals and birds, but should be interpreted with caution. Based on this finding, a couple of examples utilizing Wikipedia pageviews to guide conservation efforts will be showcased.

The regionalization of adaptive amphibian responses to climate change: lessons for conservation management in Iberian Peninsula

Alagador D¹

¹*Biodiversity Chair, MED: Mediterranean Institute for Agriculture, Environment & Development, University Évora, Évora, Portugal*

The critical dependence of amphibians on water and wetness makes them largely vulnerable to global warming. In Iberian Peninsula amphibians are particularly susceptible, as this is a region already exposed to dryness and high temperatures. I introduce a framework which, based on the geometry of sequential adaptation areas, the predictive uncertainty and land uses, provides a guideline for conservation management in the face of climate change. The vulnerability of each species to climate change is appraised using an exposure/adaptability/risk scheme. On-place climatic stress informs on exposure, adaptability is assessed using metrics about adaptive dynamics and risk of failure is related with land uses and with the geometry of suitable areas along time, which accounts on the success of conservation actions. Large dissimilarities on vulnerability expectancies among the 27 species analyzed were found. Those differences emerged particularly from the combined result of different: levels of converging trajectories; sequential overlays of suitable areas in rear and leading range edges; magnitudes of uncertainty, and land uses. Based on the regionalization of these responses, preferential portfolios of conservation actions were indicated. The framework presented is a first step towards an effective climate-resilient conservation planning for Iberian amphibians.

Market solutions for conserving farmland biodiversity: how to establish a successful wildlife-friendly certification scheme?

Alif Ž¹, Šumrada T¹

¹*University of Ljubljana, Biotechnical Faculty, Ljubljana, Slovenia*

While the dramatic loss of farmland biodiversity in Europe has typically been tackled through governmental interventions like agri-environmental schemes, this has brought little success in reversing the biodiversity decline and making farming wildlife-friendly. An alternative way to stimulate farmers to use biodiversity-friendly measures is through market-based solutions. Voluntary certification schemes are one such example where farmers implement a more sustainable production process in return for a higher price or better market access. Here we examine biodiversity-friendly certification schemes

in Europe to determine what contributes to creation of successful schemes to conserve farmland biodiversity. We compare what criteria the schemes use for wildlife-friendly farming and examine the factors that lead to the founding of wildlife-friendly certification schemes and adoption by farmers through the diffusion of innovations theory. After the initial screening, we selected nine case studies from across Europe covering different agricultural sectors and performed interviews with the scheme leaders. Most schemes are led by NGOs and require producers to manage a certain proportion of their land for biodiversity. We identify key policy interventions that can stimulate the creation and promotion of wildlife-friendly certification schemes among farmers and consumers in the future as an alternative approach for farmland biodiversity loss prevention.

Impacts of Hydropower Dams on Semi-Aquatic Megafauna

Altanov V^{1,2}, He F¹, Bremerich V¹, Jähnig S^{1,3}

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Hydropower has been developed globally, supposedly providing reliably renewable energy, increase water supply, and help with flood control. However, the impacts of hydropower dams on freshwater biodiversity have been widely documented. Most existing studies have focused on the impacts on migratory fish such as the sturgeons and salmonids, with less attention being paid to semi-aquatic species including crocodilians, turtles, and mammals which are also susceptible to hydropower development, for example, through the impairment of their breeding and feeding habitats. We conducted a systematic literature review and synthesized the effects of hydropower dams on 61 semi-aquatic megafauna species (i.e., animals that depend on both freshwater and terrestrial habitats and can reach a body mass of 30 kg). We found that the impacts of hydropower dams vary among taxonomic groups and regions. By combining the data extracted from identified studies with global distribution data of semi-aquatic megafauna and hydropower dams (i.e., existing and proposed dams), our study highlights the gaps in current assessments and emphasizes the regions of priority for monitoring and conservation actions in the future. It provides insights into the development of effective strategies that may support balancing biodiversity conservation with hydropower development.

In the trap of interacting drivers: the disintegration of extensive, traditional grassland management in Central and Eastern Europe

Babai D^{1,2}, János B³, Molnár Z^{2,4}

¹*Research Centre for the Humanities, Institute of Ethnology, Budapest, Hungary*, ²*MTA Lendület Ethnoecology Research Group, Budapest, Hungary*, ³*Local farmer, Gyimesközéplek (Lunca de Jos), Romania*, ⁴*Centre for Ecological Research, Institute of Ecology and Botany, Vácrátót, Hungary*

Micro-scale management of cultural landscapes with species-rich grasslands requires the operation of extensive land-use systems. These systems are under increasing pressure of interacting drivers that impact on farmers' individual decisions and force them to make trade-offs. We aimed to reveal the local understanding of driver interactions and related trade-offs focusing the time of haymaking, through participatory observation and semi-structured interviews in a small-scale community in a mountainous landscape (Gyimes, Romania). Local farmers perceived ecological, socio-cultural, economic, and political drivers affected the optimal and actual time of mowing and increased the number of trade-offs. Direct drivers influenced the phenology of vegetation and thus the time of mowing, while indirect social, cultural, and political drivers only impacted on the latter. The complexity of driver and trade-off interactions increased making adaptation more difficult. While farmers were navigating through the increased complexity, an informal social institution that previously optimized the work forces of farms gradually disappeared, thus decreased the economic and social viability of the system. Our results suggest that the local community's adaptive capacity has been drastically weakened. More flexible regulations are needed to assure the continuity of centuries-old but still existing traditional management systems, which maintain high-nature-value cultural landscapes.

Role of ancient historical monuments in conservation – Bronze and Iron age burial mounds as sentinels of grassland biodiversity

Balazs D¹, Valkó O¹

¹*Lendület Seed Ecology Research Group, Institute of Ecology and Botany, Centre for Ecological Research, Vácrátót, Hungary*

Due to the intensive land transformation activities during the past centuries, grassland habitats suffered a dramatic area loss, the remaining fragmented stands became isolated and often degraded due to intensification or abandonment. In continental Eurasia the millennia-old burial mounds called 'kurgans' are among the most widespread manmade landmarks, which besides verges and river balks can also maintain remnants of grassland biodiversity. By using a series of case studies, we aim to reveal the conservation role of kurgans and the ecological processes and socio-economic factors that support their biodiversity potential. Based on a continental-scale survey we revealed that 61.5% of kurgans situated outside protected areas held grassland vegetation. Focusing on Central-Europe we showed that kurgans held similarly high diversity of grassland specialist plant and arthropod taxa inside and outside protected areas, thus functioned as safe havens. We showed that in Central- and South-Europe high plant diversity on kurgans was supported by high environmental heterogeneity of the mounds enhancing species co-existence within a small area and 'island-specific' plant traits supporting persistence in habitat islands. Cultural, historical and religious values associated with kurgans also had a considerable role in the maintenance of grassland vegetation by suppressing intensive land use and ensuring extensive management.

Building a biodiversity hotspot systems in agricultural landscapes: first experiences from the Wild Flower Fields experiment, Hungary

Báldi A¹, Pellaton R¹, Bihaly Á², Sziget V¹, Lellei-Kovács E¹, Máté A³, Sárospataki M², Soltész Z¹, Somay L¹, Kovács-Hostyánszki A¹

¹*Centre for Ecological Research, Vácrátót, Hungary*, ²*Department of Zoology and Ecology, Institute of Wildlife Management and Nature Conservation, Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary*, ³*Dorcadion Ltd, Kecskemét, Hungary*

Sustainable farmlands should support both production and biodiversity. Restoration of semi-natural grasslands may improve sustainability. The size of restored patches and their landscape context are both important cofounding factors. We addressed these issues in the Kiskunság Wild Flower Field Experiment (<https://ecosystem-services.ecolres.hu/research/field-experiments>). We selected 24 circular landscape plots of 500 m radius with either homogeneous or heterogeneous environment in Central Hungary. Within 16 landscape plots, 0.5 ha parcels were sown with a 32-species seed mixture of local insect-visited plants. Eight of those were a single large field or three smaller strips in the middle with 0.5 ha in total area. The remaining 8 landscapes serve as control sites. The experiment started in 2020, and we monitor the development of vegetation, bee, hoverfly, wasp and other insect communities applying transect walk, Malaise traps, pantraps, and nest traps. The records and samples are under identification, data cleaning and analyses. Our first experiences show that (i) continuous communication with farmers is essential, as flower fields require different management (or lack of it) than farmers usually do; (ii) each field may need individual management to achieve high flower cover; and (iii) the flower fields have no effect on yield in neighbouring arable crops.

Conservation opportunities for pollinators in urban landscapes

Baldock K¹

¹*Northumbria University, Newcastle upon Tyne, United Kingdom*

Animal pollinators are currently the focus of international concern as numerous studies document their declines and the multiple threats they are facing. Pollination services by animals are crucial for healthy ecosystems as well as food security via pollination of crops. Land use change is one of the main drivers of pollinator declines, with urbanization

regarded as major threat to biodiversity.

I present findings from research on plant-pollinator communities in UK urban landscapes including the Urban Pollinators Project, a national scale study of insect pollinators in UK towns and cities involving academic and practitioner partners. We investigated three questions: (1) Where is the UK's pollinator biodiversity? (2) Where are the hot-spots of pollinator biodiversity in urban areas? (3) How can we help conserve pollinators in urban areas? I also describe patterns of floral resource availability across cities, including the important role of residential gardens.

Managing urban landscapes for pollinator conservation requires collaboration with a range of stakeholder partners. I highlight knowledge exchange activities with policymakers, practitioners and conservation organisations that aim to enhance the understanding and development of optimal land management practices that benefit urban pollinators.

Conservation genetics in the highlands; contrasting strategies in Scotland and beyond

Ball A¹, Senn H¹, Partners R

¹*Royal Zoological Society of Scotland, Edinburgh, United Kingdom*

The Royal Zoological Society of Scotland is home to the renowned WildGenes Laboratory that uses genetic data to inform conservation planning and action. With a focus on native species restoration in Scotland, the techniques and partnerships we develop for conservation here in Europe can contrast dramatically with our international work. I will introduce some of our key focuses, from the wildcats of the Scottish Highlands, through the Himalayas, to the crocodiles of the Cardamom mountains in Cambodia. I will compare and contrast some of the methods we use, from small SNP panels to whole-genome sequencing, with an emphasis on the importance of tailored approaches and the vital role of trusted partnerships across the board.

Bird responses to urbanization change depending on reference level, rural or natural

Batary P¹, Kurucz K², Suarez-Rubio M³, Chamberlain D⁴

¹*Centre for Ecological Research, Landscape and Conservation Ecology, Vácrátót, Hungary*, ²*University of Pecs, Department of Ecology, Pecs, Hungary*, ³*University of Natural Resources and Life Sciences, Institute of Zoology, Vienna, Austria*, ⁴*University of Turin, Dipartimento di Scienze della Vita e Biologia dei Sistemi, Torino, Italy*

Urbanization is one of the most extreme forms of environmental alteration, posing a major threat to biodiversity. We studied the effects of urbanization on avian communities via a systematic review using hierarchical meta-analyses. We found that urbanization had an overall strong negative effect on bird species richness, whereas abundance increased marginally with urbanization. Effects of urbanization on species richness were more negative for studies including public green spaces in the sampled landscapes. In contrast, studies performed solely in the urban matrix revealed a strong positive effect on bird abundance. When performing subset analyses on urban-suburban, suburban-rural and suburban-natural comparisons, species richness decreased from natural to urban areas, but with a stronger decrease at the urban-suburban interface, whereas bird abundance showed a clear intermediate peak along the urban-rural gradient although abundance in natural areas was comparable to that in suburban areas. This suggests that species loss happens especially at the urban-suburban interface, and that the highest abundances occur in suburban areas compared to urban or rural areas. Thus, our study shows the importance of suburban areas, where the majority of birds occur with fairly high species richness.

Mongolian herders' ecological understanding in their landscape and landscape change

Batdelger G¹

¹*Centre for Ecological Research, Budapest, Hungary*

Evidence shows that Mongolian herder's knowledge can serve as a valuable body of information about ongoing ecological processes. Our study areas were located in the mountain forest-steppe region in Mongolia. In 2017–2020, we interviewed 33 people using photos of

plant species and habitats and semi-structured interviews focusing on landscape change.

Herders distinguished 88 folk habitat types, and we documented the habitat preference of 76 plant species. The habitat classification was multidimensional; key dimensions were geomorphological and edaphic. There were some species (e.g., *botyuul* – *Festuca lenensis*, shireg – dominated by *Carex duriuscula* and species groups (hot and leafy plants) that were often used to describe habitat types.

We found 32 indicators of landscape changes for the 14 main habitat types studied. Herders attributed various changes to diverse drivers. Some of the long-term trends reported by herders are well-known, others are rarely mentioned in the scientific literature, if at all. South-facing mountain slopes and flat areas in valleys are changing most rapidly. Herders wish to cooperate with each other to deal with adverse changes: to increase mobility, stop overgrazing, and help nature to regenerate. Herders have a reliable and widely shared understanding of landscape changes that could help with this cooperation.

Sacred natural sites in space and time

Bhagwat S¹

¹The Open University, Milton Keynes, United Kingdom

The tradition of maintaining 'sacred natural sites' can be traced in many indigenous societies. These sites are considered important in the development of religion and spirituality in our distant ancestors and today they demonstrate the special relationship between people and nature. Numerous examples of sacred trees, groves, forests, ponds, lakes and rivers exist throughout the world. These hundreds of thousands of sites are distributed across all inhabited continents. This talk will present an overarching perspective on sacred natural sites that spans their global distribution and their historical origins. I will draw on a number of case studies from around the world to illustrate the development of sacred natural sites in space and in time.

Bugs at your service: recent insights into biocontrol and pollination in crop production systems

Bianchi F¹

¹Associate Professor, Wageningen University, Wageningen, Netherlands

Mobile arthropods provide important ecosystem services to support crop production, including pest suppression and pollination. These arthropods depend on the life-support functions provided by the landscape, but at the same time intensive management practices in the landscape may pose threats for these arthropods. In this presentation I will give an overview of the work of my group in the past years and highlight how pest, natural enemy and pollinator populations are influenced by interactions between resource availability, insecticide use and their movement. These insights will contribute to the development of design rules for biodiversity-friendly landscapes that support arthropod-based ecosystem services.

Using the Ethical Matrix for analyzing value conflicts in conservation

Biasetti P¹, de Mori B²

¹Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany, ²University of Padua, Padua, Italy

Conservationists often have to deal with intricate conflicts between competing interests, demands, and values. Conservation projects, for instance, can produce inequities among social groups and people. When they involve the manipulation of wildlife, they can negatively impact animal welfare. Implicit value judgments may create contrasts in priority-setting. And so on. When not addressed, these and other similar ethically relevant issues may undermine the chances of success of a conservation project. Ethical analysis can help by providing conservationists with the means for anticipating potential conflicts. Here, we discuss an existing conceptual tool for ethical analysis—the Ethical Matrix (EM)—in a version explicitly tailored to biodiversity conservation. After briefly describing the EM in its specific adaptation to the context of ethical analysis in conservation—by focusing on what the tool is, why to use it, and how to use it—we will present some examples of its application. In this way, it will be shown how the EM can

be used to unpack the values involved in an entangled conservation scenario, assess the impact of different decisions on stakeholders, and map the potential conflicts, exploring the existing possibilities for compromise between different ethical demands.

Climate change mitigation targets compromise forest ecosystem services and biodiversity

Blattert C^{1,2}, Mönkkönen M^{1,2}, Burgas D^{1,2}, Di Fulvio F³, Toraño Caico A⁴, Vergarechea M⁵, Klein J⁶, Hartikainen M⁷, Antón-Fernández C⁵, Astrup R⁵, Forsell N³, Lukkarinen J⁸, Lundström J⁹, Pitzén S⁸, Poschenrieder W⁴, Primmer E⁸, Snäll T⁶, Eyvindson K^{1,10}

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The EU decided on clear climate change mitigation targets to reach climate neutrality, also taking into account forests and their timber resources. We investigate consequences of increased timber demands resulting from EU mitigations targets on the objectives of national forest sectoral policies for forest ecosystem services and biodiversity (FESB). Using three Nordic countries (Finland, Sweden and Norway) and Germany as study regions, we first simulate forest dynamics and management to gain information on the future FESB provision. Second, we model the future timber demands for each region related to EU climate change mitigation targets, and elaborate FESB demands stated in national policy documents. Third, we resolve the optimal forest management for EU-level and national-level policy demands and analyze the cross-scale policy coherence. We show that key European timber-producing countries (Finland, Sweden, Germany) may not be able to cover increased timber demands for material and bioenergy usage arising under the ambitious 1.5 °C target. Focusing on EU mitigation targets further conflicts with national sectoral policies and cause adverse effects on multiple forest ecosystem services and biodiversity. We argue that the role of forest and its timber resources for achieving targets on climate change mitigation and societal decarbonization should not be overstated.

Opportunities and limitations for the range expansion of European bison and moose in Europe

Bluhm H¹, Kümmerle T¹

¹Geography Department, Humboldt Universität zu Berlin, Berlin, Germany

The recent rebounding of large mammals in Europe is a hopeful trend for conservation. Knowing where recolonizations are possible is crucial to guide conservation planning and to proactively manage conflicts, but broad-scale assessments of recovery potential are missing for most species. We assessed the recolonization potential of Europe's two largest herbivores, the European bison (*Bison bonasus*) and moose (*Alces alces*), across Central Europe. Using large occurrence datasets from multiple populations, we separately assessed environmental habitat suitability and human pressure on these species. We then modeled landscape connectivity as well as directed westward movements originating from extant populations to assess recolonization opportunities and limitations. We identified widespread environmentally-suitable habitat for both, European bison (>120,000 km²) and moose (>244,000 km²), showing a substantial potential for recolonizations. However, many potential habitat patches were associated with high levels of human pressure (European bison: 37%, moose: 43%), particularly in western regions of our study area, indicating high risk for human-wildlife conflicts. Moreover, we identified a strong east-west gradient of decreasing connectivity, as well as substantial barriers that likely limit natural recolonization processes. Our results suggest that conservation measures fostering the return of large herbivores should prioritize on restoring broad-scale connectivity in Europe's increasingly fragmented landscapes.

Intercropping oats with undersown clovers supports pollinators without reducing yields

Boetzel F¹, Douhan Sundahl A¹, Friberg H¹, Viketoft M¹, Bergkvist G¹, Lundin O¹

¹Swedish University of Agricultural Sciences (slu), Uppsala, Sweden

Conserving biodiversity and biodiversity mediated ecosystem services commonly clashes with maintaining productivity levels in agriculture. Increasing within field vegetation diversity by intercropping with legumes seems promising but the effects on biodiversity and ecosystem services are so far not sufficiently understood. Using 26 semi-field plots in a paired design, we studied the effects of intercropping oats with a mixture of three annual undersown clovers on pollinators, arable weed control and natural pest control. We found beneficial effects on pollinators and arable weed suppression but no effects on most natural enemies and a slightly negative effect on spiders. Neither pest damages nor natural pest control or crop yields were affected by intercropping. The biomass of undersown clovers was positively correlated with flower cover, pollinator densities and arable weed suppression. We demonstrate that undersowing annual clovers is a simple and comparably cheap method to suppress arable weeds (and thereby reduce herbicide inputs) and support pollinators without sacrificing cereal crop yields or taking land out of arable production. Intercropped plant mixtures should, however, be optimised to support a wider spectrum of pollinators and benefit natural enemies and natural pest control in order to support a higher level of overall cropping system biodiversity and multi-functionality.

Modelling and managing animal and human movements in social-ecological systems

Borger L¹, Potts J², Loison A³

¹Swansea University, Swansea, United Kingdom, ²University of Sheffield, Sheffield, UK, ³Université Savoie Mont Blanc, Chambéry, France

Movement is a key mechanistic driver of processes in intertwined social-ecological systems (SESS), connecting individuals and processes across multiple spatio-temporal scales and leading to the emergence of complex spatio-temporal patterns. Here we present a set of case studies, firstly showing new modelling frameworks to understand the drivers of real animal turning decisions, as well as identify and quantify the energetic drivers underlying animal foraging and habitat selection patterns, including the energetic costs and gains of movement and foraging. Secondly, we show how to disentangle complex movement decisions animals face when confronted with co-occurring lethal and non-lethal human disturbances, an increasingly common case in social-ecological systems. Third, we present how these mechanistic modelling approaches, focussing on fine-scale movement decisions of individuals, can be scaled up to quantify and predict the emergence of broader-scale spatial and temporal patterns of space use of both single and interacting individuals, as well as help identify missing drivers of individual movement decisions. We discuss how and when these methods, which include statistical and mathematical modelling approaches, can be used and how they can inform management decisions.

Ecological barriers mediate spatiotemporal shifts of bird communities across Europe

Bosco L¹, Marjakangas E¹, Versluijs M¹, Xu Y¹, Santangeli A¹, Holopainen S¹, Mäkeläinen S¹, Lehikoinen A¹

¹Finnish Museum of Natural History, Helsinki, Finland

Species' range shifts and local extinctions caused by global change lead to community composition changes. At large spatial scales, ecological barriers, such as biome boundaries, coastlines, elevation, and temperature gradients, can influence a community's ability to shift. Yet, ecological barriers are rarely considered in global change studies, potentially hindering predictions of biodiversity shifts. We used data from two consecutive European breeding bird atlases to calculate the geographic distance and direction between communities in the 1980's and their nearest compositional equivalent in the 2010's and modelled their response to barriers. The ecological barriers affected both the distance and direction of bird community composition shifts, with coastlines and elevation having the strongest influence. Combining ecological barriers and community shift projections can

identify ecological corridors that facilitate shifts of species and communities under global change.

Agriculture and biodiversity in Europe: challenges and opportunities ahead for the CAP

Bradley H¹

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Harriet Bradley will give a broad overview of the challenges and opportunities ahead for the CAP to support and conserve farmland biodiversity, and more broadly, agro-ecosystems' health. This will cover a summary of the evidence of the CAP's impact to date, along with the best available evidence on the impacts of the incoming CAP on farmland species and habitats and agro-ecosystem health. The talk will draw on the analysis that IEEP has carried out on the 2023–2027 CAP Strategic Plans of EU Member States, along with previous work by Ms Bradley on the impacts of the CAP on biodiversity and the likely impacts of the new CAP reform whilst working at the nature conservation organisation BirdLife Europe.

The Twiga Tracker Initiative: Merging Site Specific Conservation Management with Continental Scale Ecological Studies for Giraffe

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Giraffe are distributed across populations in 21 African countries, each with unique habitat characteristics, sociopolitical contexts, threats, and conservation opportunities. Effective conservation of these imperiled species requires clear understandings of ecological requirements, data-driven management strategies, and analytical frameworks for applying ecological theory towards conservation objectives across these populations. Through the Twiga Tracker Initiative, a collaborative partnership spearheaded by the Giraffe Conservation Foundation and the Smithsonian Conservation Biology Institute, researchers and conservation practitioners collaboratively deployed over 300 GPS tracking devices on giraffe across thirteen countries. Each project aspires to leverage the unique aspects of each site to cast new insight on giraffe ecology, generate actionable real-time data for site specific conservation objectives, and contribute to continental scale giraffe spatial ecology studies. This multi-scale approach to conservation and research is built on a foundation of strong collaboration with key stakeholders to define mutual research/conservation objectives. Pioneering the applications of data sharing platforms, the Twiga Tracker Initiative provides real-time visualisation and analytics of incoming giraffe data to meet local conservation goals, while providing central data repositories for larger scale ecology studies. In this presentation, we will explore case studies of these applications for harmonizing conservation and ecology research using giraffe tracking data.

Conservation frontiers – Understanding relationships between expanding land use and expanding conservation efforts

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Land-use frontiers, such as agriculture expanding into natural forests in the Global South, continue to be a major driver of biodiversity loss and frequently trigger conservation responses. With the increasing geographic footprint of area-based conservation, land conservation can be considered a major land use itself. Using tools and concepts from Land System Science – the field studying land use as a social-ecological system – therefore should provide opportunities to better understand the patterns, actors, and drivers of land conservation. Here, we propose that land conservation can be usefully examined through the concept of frontiers, and specifically three different per-

spectives related to frontiers. First, conservation can be defined as efforts to slow or halt other frontiers (e.g. deforestation). Second, expanding land conservation could be described as a frontier process itself, leading to similar institutional and cultural reorganization, as well as conflict (e.g. green grabbing). Finally, frontiers can be viewed as spaces where multiple land uses, including conservation, interact. Bridging the disciplines of Land System Science and Conservation Science, as we propose here, could enable a deeper consideration of the social-ecological contexts in which conservation occurs, and thus support better conservation planning.

Engaging a billion people to foster coexistence with megafauna from local to global scales and back

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How people respond to change will ultimately determine the degree to which landscapes of coexistence between people and megafauna can be realised. Over 2.7 billion people play online games on a regular basis, but very little of this game play time is used to advance our knowledge or to tackle environmental challenges. In this talk, we will 1) present the games we have used and the data we have gathered with over 700 game players in Europe and Africa to understand people's decisions towards conservation of land and wildlife; 2) provide a roadmap for the use of online games as an experimental and observational tool to collect data on people's decisions in complex social-ecological systems; and 3) discuss the potentials, limitations and ethical concerns when collecting large scale data on people's decisions.

Boreal forests and restorative health benefits to humans: management recommendations, synergies and trade-offs

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There are increasing demands from forests to provide more wood and fulfil a broader range of ecosystem services while simultaneously improving forest habitats to preserve biodiversity. Although policy-makers and forest professionals acknowledge the restorative benefits of forests for human health, this dimension is seldom accounted for, partly due to the lack of tools to quantify such aspect. In this interdisciplinary study, we present the relative contribution of different management practices to restorative health value of forests, and inspect the trade-offs and synergies between health and biodiversity, and other ecosystem services. We here use a novel framework that accounts for the different perceived sensory dimensions that allows us to link forest physical characteristics to restorative benefits for humans. We simulated the growth of a commercial forest landscape in central Finland 100 years into the future for a broad representation of management regimes. We use multiobjective optimization to find the best combination of managements and trade-offs among health, ecosystem services and biodiversity. Continuous cover forestry has the largest contribution to the restorative value of forests, followed by set-asides and rotation forest management practices. This links to multiple synergies and trade-offs.

A European platform of forest multi-taxon biodiversity and stand structure data

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The maintenance of forest biodiversity in Europe strongly relies on the concept of sustainable forest management. Nevertheless, current forest management has an important impact on forest biodiversity and was identified as the main pressure for most European forest habitats.

Current indicators for the sustainability of forest management either account only for trees, or are indirect biodiversity proxies. Broad-scale forest biodiversity data are still lacking in national and continental forest information systems.

Several groups of scientists across Europe took up the challenge of multi-taxon field sampling through local projects on the effects of forest management on overall forest biodiversity. The COST Action "BOTTOMS-UP" collected multi-taxon data to build a comprehensive platform of European forest biodiversity. Up to now, we standardized and merged 36 different datasets encompassing 3,595 sampling units across 13 out of 14 forest categories and 12 European countries. Each sampling unit was surveyed for at least three taxonomic groups and for individual tree measures, and associated with a specific forest management system.

We found that differences in biodiversity sustainability across management systems are scale and taxon dependent. Broad-scale monitoring networks should account for these differences and be tailored on specific conservation objectives.

Observing the flowering phenology of an invasive succulent through the lens of social media

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Analyses of digitally generated and stored data can reveal ecological patterns and processes that would otherwise be difficult to study; this approach has recently emerged as iEcology. Plant reproductive success is an important trait influencing invasiveness, and it strongly depends on flowering phenology. To ensure fecundity and successful development of seeds, invasive plants need to adjust their flowering to the most appropriate time of the year in their introduced ranges. Here, we apply iEcology tools to study the flowering phenology of the South African succulent taxa of the genus *Carpobrotus* that are amongst the most problematic invasive plants in coastal areas worldwide. We assessed user-generated data from geolocated pictures obtained from Instagram, a social network platform, at key tourist sites across multiple countries to record the phenological patterns of *Carpobrotus* spp. populations in the past 5 years. Our results suggest that iEcology provides a cost-effective approach to compare flowering periods of plants across their native and introduced ranges.

Biodiversity monitoring and forecasting to support the Bioeconomy Strategy and EU citizens at large

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Essential biodiversity and ecosystem services variable (EBVs and EESVs) workflows are a key step to demonstrate the value of harmonized, multi-source streamlines of observation data in short-term forecasts of ecosystem services and disservices. Business opportunities and impacts associated with such real-time data can support the EU Bioeconomy strategy and EU citizens at large. Here we will

showcase how a European Biodiversity Observation Network can support the Bioeconomy Strategy, by developing models to produce short-term spatial forecasts of biological phenomena that are relevant for economy and society. We will focus on a case study where we forecast the fructification of wild mushroom species.

Linking socioeconomic status and urban biodiversity: are rich areas species-rich?

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Urban biodiversity, and its associated ecosystem services, is an important component of the quality of life of urban residents. The Luxury Effect posits a positive association between biodiversity and socioeconomic status in urban areas, and is thus reflective of environmental injustice, as the benefits associated with biodiversity are not equitably shared across society. Our meta-analysis showed there was a positive association between terrestrial biodiversity measures and socioeconomic status. Furthermore, the strength of the Luxury Effect was greater in arid areas. Many key and emerging climate impacts are concentrated in urban areas, thus the degree of environmental injustice represented by the Luxury Effect may be amplified in the future, especially in arid regions. However, there were biases in geographic coverage (more studies in the developed world) and taxonomic groups (most studies were on plants and birds) in the publications considered. Furthermore, some studies have revealed complex interactions between urban land cover and socioeconomic status. Here, we suggest the research priorities that are needed to fully understand mechanisms driving the Luxury Effect. This is necessary to develop strategies for sustainable development of cities and thus to promote environmental justice, enhancing the quality of life of urban residents across all sectors of society.

Plant protection by the Natura 2000 network across EU countries

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The biodiversity crisis is calling for urgent and effective measures of protection. Area-based conservation is a strategic pillar in the European Biodiversity Strategy, which aims to effectively protect 30% of area of member states by 2030. However, an assessment of the effectiveness of EU protected areas for plant biodiversity is still missing, limiting conservation planning capacity. With this project, we address the effectiveness of plant protection by the Natura 2000 Network across EU, using one of the largest plant diversity dataset, the European Vegetation Archive. We obtained a dataset composed by 1,223,017 vegetation plots. Species nomenclature and origin was standardized according to Euro+Med and we then focused the analyses on native species only. By overlapping plot location with the Natura 2000 network, we calculated alpha, beta and gamma diversity within and outside the network and compared these values across countries, biogeographic regions and habitat types. The Natura 2000 was found to host a significant portion of plant diversity, but differences are highlighted across countries, biogeographic regions and habitat types. The results here presented offer a baseline for the conservation planning needed to expand the Natura 2000 Network and achieve the targets for area-based conservation delineated in the European Biodiversity Strategy.

Nature apps – Gaining Ecological and Conservation Insights from Dedicated Smartphone Applications

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The increase in people's digital interactions via smart devices also generates accessible and voluminous nature-related content. Dedicated nature-related apps (i.e., nature apps) can increase human-nature interactions for the benefit of both and provide valuable scientific insights. However, the true potential of nature apps for ecology and conservation remains limited. Here, we assessed currently available nature apps and their attributes to better understand how their impact can be maximized. We used 178 nature-related search keywords in the Google Play Store and obtained 3151 apps, of which 1723 were classified as nature apps (after further assessment). Recent years have seen an increase in nature app downloads. However, their average ranking with users was lower than those for all apps in the Google Play Store. Many apps were dedicated to promoting people's outdoor activities, natural-history interactions, and education. Apps dedicated to birding and nature watching were the most popular. Attributes such as virtual reality, species recognition, or gamification made apps more popular with users, however, their implementation in nature apps is still low. Our findings can help both scientists aiming to use insights from nature apps to better understand human-nature relationships, and nature app developers to develop apps providing richer nature engagements.

High biodiversity areas preserve Nature's Contributions to People under climate change

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Increasing human pressures are driving global biodiversity loss, dramatically affecting the provision of Nature's Contributions to People. Here, we estimated how preserving regions with a high biodiversity value could reduce the risk of diminishing the provision of NCP, and thus contributing to the achievement of different Sustainable Development Goals (SDGs). We analysed four different scenarios of global environmental change from CMIP6, selecting few data proxies of regulating NCP indicators to measure the change status of NCPs in the future, specifically, the regulation of air quality (NCP3), climate (NCP4) and freshwater quantity (NCP6). For each indicator, we evaluated whether risk from environmental change to the provision of regulating NCPs is higher or lower within priority conservation regions compared to not priority regions. Our results highlighted that there was an overall increasing trend of NCP3 and NCP4 worldwide, while NCP6 showed contrasting results depending on the area. Furthermore, the change in the provision of NCP was globally higher in regions of high biodiversity value compared to others but there were also many country-specific exceptions. Identifying the relative contribution of high biodiversity areas to NCP provision allowed us to pinpoint possible synergies between the achievement of multiple SDGs under alternative future conditions.

Urban conservation and restoration in times of climate change: going beyond a little bit of 'greening'

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It is increasingly recognized that nature in cities plays an important role for mitigating and adapting to climate change, for human-being and for biodiversity. Policy attention for urban conservation

and restoration has increased substantially in recent years. Most of the commitments are voluntary and legally non-binding. If people want to survive in cities in times of climate change, substantial efforts for conserving and restoring nature in urban environments will be necessary. In this presentation we will analyze recent commitments in the (draft) post 2020 biodiversity framework under the Biodiversity Convention, as well as the commitments in the EU biodiversity strategy 2030. We discuss EU legally binding provisions that could be applied to urban environments and the need for additional binding provisions (such as the EU nature restoration law). We address the issue of what restoration means for urban environments: can it go beyond mere greening, remediation and rehabilitation and restore native ecosystems. We will also address the role of private actors and will discuss the Biodiversity plan of Ghent University as an example.

Simple nestbox modifications can reduce drastic heat-related mortality in lesser kestrel *Falco naumanni* nestlings

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The increased frequency and intensity of heatwaves associated with climate change can have major impacts on bird conservation. The lesser kestrel *Falco naumanni* dependency on old buildings for nesting, along with agriculture transformation, caused a decline of the Mediterranean population in the last decades, but recent heatwave events represent a cause of further conservation concern. We report the effects of the 2021 heatwave on the reproductive success of a large lesser kestrel nestbox colony in southern Italy (Matera). To tease apart the heatwave effects on nest microclimate from those on the external environment, we either shaded or left unmanipulated (control) nestboxes at hatching. As expected, shaded nestboxes were on average 4.2 °C cooler inside than controls. We observed an increased survival (shaded 85%, control 20%), body mass (+12%) and tarsus length (+3%) in nestlings from shaded nestboxes. These results indicate that heatwaves have direct, strong effects on nestling (and presumably post-fledging) survival. These results suggest that nest microclimate will be a major factor affecting population dynamics and conservation of this and possibly other Mediterranean birds breeding in nestboxes, underlining the need of designing nestboxes that can minimize the effect of future heatwaves.

Digital data sources and methods for conservation culturomics

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The Information Age provides new opportunities to better understand human-nature interactions as many aspects of daily life are recorded in a variety of digital formats. Conservation culturomics aims to take advantage of digital data sources and methods to study human-nature interactions and thus to provide new tools for studying conservation at relevant temporal and spatial scales. Still, technical challenges associated with the identification, access, and analysis of relevant data hamper the wider adoption of culturomics methods. To help overcome these barriers, a conservation culturomics research framework is outlined that addresses data acquisition, analysis, and inherent biases. The main sources of culturomic data include web pages, social media, and other digital platforms from which metrics of content and engagement can be obtained. Obtaining raw data from these platforms is usually desirable but requires careful consideration of how to access, store, and prepare the data for analysis. Methods for data analysis include network approaches to explore connections between topics, time-series analysis for temporal data, and spatial modeling to highlight spatial patterns. Outstanding challenges associated with culturomics research include issues of in-

terdisciplinarity, ethics, data biases, and validation. The framework provides practical guidance that will facilitate the wider adoption of culturomics approaches for conservation.

Forest and poverty: Hidden contributions of forest to multidimensional poverty

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Most research on forest-poverty dynamics has studied the effect of forest-related policies on monetary poverty, ecosystem services, agricultural productivity, and food security. These policies modify and shape forest landscapes; however, the effect of forest configuration on eradication and/or poverty alleviation remains unknown. Here, we estimate the impact of forest cover and forest configuration on poverty, for which we use a series of cross-sectional data that integrate multidimensional poverty (MPI) values with high-resolution forest cover data for more than 3000 rural households in Peru. Our results show 1) the effect of the forest on overall multidimensional poverty and 2) its effect on each MPI dimension: health, education, and standard of living. We find that the effect of forest cover and forest configuration on poverty depends on the outcome. Forest cover and the number of patches are positively associated with levels of deprivation in education and standard of living, but show a negative relationship with levels of deprivation in health, specifically child nutrition. Thus, clusters with a larger amount of forest will present a better level of child nutrition. These results demonstrate the complexity of forest-poverty dynamics and highlight the links between forest conservation and human well-being.

Using plant genetics to investigate how landscape change, habitat fragmentation and connectivity affect diversity

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Ancient grasslands have some of the highest plant species richness in Europe. A long continuity of management and spatial connectivity is a prerequisite for the high species richness we can find there today. But at the same time, grasslands are threatened by habitat change and fragmentation. In three different research projects we analysed genetic diversity of *Campanula rotundifolia* or *Galium verum* to understand how habitat fragmentation have influenced the species, as indicators for community diversity. We used historical maps and aerial photographs from 36 landscapes in Europe, 48 in Sweden and several islands in the Stockholm archipelago to investigate grassland change over time. We found that grazing networks imprinted strong landscape-scale spatial patterning in pairwise population genetic differentiation and within-population genetic diversity of *C. rotundifolia*. In landscapes where ancient grasslands have disappeared landscape heterogeneity becomes more important to sustain large-scale populations and thus genetic diversity of *C. rotundifolia*. We found that the green infrastructure in the surrounding landscape were a genetic subset of the focal grassland populations of *G. verum*. Particularly a network of road verges supported gene flow from grasslands into the surrounding landscape. Our work highlights the importance of protecting ancient grasslands as they contain unique genetic diversity.

The effect of climate and land use change interactions on species' distribution change in Great Britain

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Anthropogenic global change is the most prominent threat for the conservation of biodiversity, and species' responses to its components are mediated by ecological and life history traits. Land use change is currently the main driver of habitat destruction and fragmentation, while climate change is already having a pervasive effect

on most of the world's biodiversity. When acting in concert, these drivers can interact to enhance the rates of biodiversity change, but past studies have tended to report that these interactions are relatively scarce and contextually restricted. Using datasets of validated occurrence records, we created occupancy maps for 49 terrestrial mammal species in Great Britain at 1-km scale resolution between 1960 and 2017. We grouped occurrences into two time periods and estimated extirpation and colonization rates, determining the extent to which distribution changes were a combined function of species' traits, land use change, climate change, or interaction between these latter two drivers. Preliminary analyses revealed that responses were often trait-dependent, with specialist species more likely to be sensitive to environmental alterations. A fuller understanding of the drivers of range shifting will improve our ability to more precisely attribute change and help prioritize efforts for the conservation of exposed species and habitats.

Exploring the coexistence potential for humans and megafauna in future European landscapes

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Megafauna comeback in Europe is a remarkable success for conservation. This trend is favored by revised hunting regulations, implemented legal protection, and structural change in agriculture that leads to farmland abandonment and outmigration from rural areas. The narrative of European megafauna comeback often focus on positive outcomes such as the restoration of trophic chains in degraded ecosystems, which links to an increased delivery of ecosystem services to humans. However, a key aspect in this context is also the evaluation of coexistence potential for humans and megafauna. Husbandry and farming methods in Europe have developed for decades in a context without free-roaming large animals. Therefore, the risk of an escalation in livestock depredation, or excessive frequency of crop-raiding events, is concrete, and it would lead to decreasing support for conservation by citizens. In this study, we estimate potential future megafauna distribution in Europe under multiple scenarios of social dynamics. With distribution thus mapped, we indicate both pros and cons of megafauna comeback. This by 1) mapping hotspots of ecosystem restoration – comparing with deep-past biodiversity baselines – and 2) mapping hotspots for human-wildlife conflict. This last estimation is pivotal to prevent drawbacks caused by megafauna comeback and enhance odds for coexistence.

Are key trophic interactions of large carnivores maintained in human-dominated landscapes? Insights from DNA metabarcoding

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Under increasing anthropogenic pressures, dietary studies are crucial for the conservation of wildlife species and the ecosystem services they provide. We assessed the diet of brown bears (*Ursus arctos*) by DNA metabarcoding in two areas with different levels of human activities and disturbance, in the Polish Carpathians and in the Italian Alps. In both areas, brown bears' diet showed a marked seasonality, characterized by a wide variety of natural foods, mostly plants and insects. In the Carpathians, fleshy-fruited plants were present in 56% of faeces, suggesting that brown bears are important seed dispersers. In the Alps, females had a more diverse diet than males, especially older males, and occurrence of major food items differed among bear sex and age categories. Occurrence of anthropogenic food was limited in both areas, but lower in the Carpathians than in the Alps. Low incidence of food associated to human activities was found also

for wolves in Slovenia and brown bears in the Pyrenees using the same approach. Our results suggest that large carnivores can play their ecological role through the maintenance of key trophic interactions also in human-modified ecosystems. Appropriate management is fundamental for preserving the ecosystem services these animals provide.

Evaluating global progress in awareness of biodiversity and conservation action worldwide

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The Convention for Biological Diversity first target for the last decade was to increase awareness of biodiversity and conservation. Public awareness of biodiversity and conservation is important for fostering pro-conservation behavior and advocacy. We used data on Google searches to evaluate the success in achieving this target, and investigated the socioeconomic factors driving differences between countries. We found partial success for the target globally. Global interest for biodiversity increased, driven mostly by charismatic fauna, while interest for conservation decreased, driven mostly by a decline in searches for national parks after the 2019 pandemic. Economic inequality had a negative effect in interest for biodiversity and conservation, while purchasing power had an indirect positive effect through education and research. Interest for biodiversity and conservation may be increased in the next decade with outreach campaigns focusing on charismatic species, institutional support for national parks, environmental education, conservation research and reduction of economic inequality.

Grassland management effects on ecosystem service delivery

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Biodiversity-friendly grassland management practices are widely implemented biodiversity interventions in agricultural landscapes, reflecting the high biodiversity and the severe environmental threats associated with grassland habitats across Europe. But effective conservation of grassland biodiversity and ecosystem functions requires insight in their relations with grassland habitat characteristics, and in how this compares with farmers' interests from grasslands. In this light, patterns of species richness and abundance of plants, wild bees and earthworms across a grassland intensification gradient in the Netherlands are presented. While plants and wild bees relate negatively to grassland productivity, earthworms do not. Assessed soil ecosystem functions also relate negatively to grassland productivity but positively to floral diversity. These results indicate a trade off between farmer interests and societal benefits from grasslands, that needs to be quantified in order to develop successful interventions to conserve grassland biodiversity and ecosystem functions.

The EU Forest Strategy, the opposition and the way forward

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Forests cover 40% of European territories, providing diverse provisioning, regulating, supporting and cultural ecosystem services. Climate change, biodiversity loss and intensive forestry practices pose huge challenges to forests, leading the European Union (EU) to recently adopt ambitious policies including the European Green Deal, the EU Biodiversity Strategy to 2030 and the European Forest Strategy 2030. These policies contain normative policy objectives of a transformative move towards enhanced climate protection, biodiversity conservation and sustainable forest bioeconomy. Nevertheless, the EU Forest Strategy remains a non-binding agreement, that MS do not have to follow, due to the subsidiarity principle and the lack of recognition of European competences on Forests. Still, the Commission

works on defining close-to-nature forestry practices and develop common best practices. The large number of laws, regulations and initiative reports influencing the forests in Europe is huge, and no harmonization can happen if the competences of the EU on forests are not recognized. Based on the diagnostic of barriers and potentials it is possible to show the way forward to reach harmonised regulations and how to experience a real shift towards more forest conservation and real sustainable forest management in the EU.

A bird in the bush worth two on the feeder? The complex question of food provisioning.

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Feeding birds is a common activity in many countries, especially during winter. Supplementary food can influence survival and reproduction, and therefore impact bird populations and communities. However, we know less about the provisioner's perspective: this is critical to make policy decisions that benefit both birds and people. Feeding birds can enhance people's connection to nature, but do people feed birds differently in rural and urban areas? Are people changing what and how they feed birds over time? What are the reasons for these changes? Here we investigate temporal changes in peoples' food provisioning behaviour in Finland using information from two long-term monitoring datasets. In addition, we conducted an online survey (over 14,000 respondents) to reveal reasons for the changes that we detected. We find that due to recommendations of local governments and housing organisations in response to a perceived rat problem, food provisioning is declining in urban areas. Without such regulation, provisioning is increasing in rural areas. However, having more birds at feeding sites was a strong motivation for changing feeding habits across the board. Our results show that winter food provisioning involves complex decisions and is affected by factors beyond attracting birds.

A counterfactual approach to evaluating the effectiveness of biodiversity offsets – Case study of the Ambatovy mine in Madagascar

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Meeting the Sustainable Development Goals requires reconciling development with biodiversity conservation. Governments and lenders increasingly call for major industrial developments to offset unavoidable biodiversity loss, but there are few robust evaluations of whether offset interventions ensure No Net Loss (NNL) of biodiversity. We focus on the biodiversity offsets associated with the high-profile Ambatovy mine in Madagascar and evaluate their effectiveness at delivering NNL of forest. As part of their efforts to mitigate biodiversity loss, Ambatovy compensate for forest clearance at the mine site by slowing deforestation driven by small-scale agriculture elsewhere. Using a range of methods, including extensive robustness checks exploring 116 alternative model specifications, we show that the offsets are on track to avert as much deforestation as was caused by the mine. This encouraging result shows that biodiversity offsetting can contribute towards mitigating environmental damage from a major industrial development, even within a weak state, but there remain important caveats with broad application. Our approach could serve as a template to facilitate other evaluations and so build a stronger evidence-base of the effectiveness of No Net Loss interventions.

National timber harvest projections under the EU Green Deal and 2030 biodiversity strategy

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The 2030 EU biodiversity strategy has the objective of protecting 30% of EU27 land and strictly protect 10% of it. Furthermore, the European Commission FitFor55 climate package has increased the mitigation demand from forests, for reaching the EU27 climate neutrality by 2050. Therefore, the objective our study has been to project future timber harvest levels for Europe (EU27+UK+Norway) and analyzing spatial allocation of harvest areas and leakages outside Europe, under scenarios integrating the 2030 biodiversity strategy and climate mitigation objectives. We applied the Global Biosphere Management (GLOBIOM) model for optimizing allocation of forest harvest across Europe. In addition, we considered alternatives where the European protection targets may be reached as an overarching target or fulfilled by each country. Our results shows that the implementation of the biodiversity strategy at European level would lead only to a 3–5% reduction in overall harvest levels in 2050, compared to a baseline. At the same time, fulfillment of the targets will reduce European wood-based products net exports by 8–25%, depending on how the biodiversity strategy is implemented. Hence, it would be relevant for policy makers to consider our study for allocating future protection in a way that will not undermine EU forest sector competitiveness.

Social media in conservation science: opportunities, challenges and going forward

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Social media data are increasingly used as a source of information in conservation science. Social media content and metadata are useful to study people–nature interactions and how they affect the global biodiversity crisis. During the presentation I will explain how social media data can be used as a novel source of information to investigate threats to and opportunities for the conservation of biodiversity. I will also focus on some of the greatest challenges of using social media data in research, especially data access and data privacy concerns. I will conclude by examining some of the ways forward to mainstreaming the use of social media data in conservation science.

Biocultural approaches to advance the inclusion of traditional ecological knowledge in conservation in Europe

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Biocultural approaches acknowledge and study the multiple relationships between the diversity of cultures and the maintenance, enhancement and creation of biodiversity through the management of species and landscapes. Biocultural approaches are seen as appropriate to address sustainability challenges across scales towards sustaining plural and just futures and their application is burgeoning in many scientific disciplines and beyond. This contribution is based on a systematic review of the scientific literature on biocultural approaches in Spanish and English language published between 1990 and 2021. The results show that biocultural approaches touch on many sustainability issues and that conservation appears as the focus emphasized in the majority of the articles reviewed. Also, local and traditional knowledge was the knowledge type most frequently studied, though the engagement with TEK holders was mainly based on consultation or information. We highlight key insights from these bodies of literature that could help in promoting biocultural conservation through processes rooted in the rights, needs, knowledge and customary practices of those who remain stewards of biocultural diversity for a more legitimate and inclusive conservation in Europe, where TEK is still largely neglected in conservation.

The potential for EU Common Agricultural Policy measures to support wild pollinators on farmland

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We evaluated the potential for habitat and landscape features required under the EU Common Agricultural Policy (CAP; 2014–2020) to support wild insect pollinators. We used structured expert elicitation, involving 22 experts from 18 European countries. Ecological Focus Area (EFA) options were scored for their potential to provide forage, nesting sites and larval resources to key pollinating taxa (i.e. bumble bees, solitary bees and hoverflies), under both standard and pollinator-friendly management. We examined initial uptake of the EFA options in terms of land area. EFA options varied geographically and temporally in the resources they were perceived to provide. For example, field margins provide good forage throughout the season in Southern and Eastern Europe but lack early-season forage in Northern and Western Europe. Under standard management, no single EFA option scored highly across resource categories. A scarcity of late season forage was perceived. Experts identified substantial opportunities to improve habitat quality through pollinator-friendly management. Improving management alone was unlikely to ensure that all pollinator resource requirements were met. We conclude that poor management, differences in pollinator habitat quality and uptake bias towards crop-based options severely limited the support provided to pollinators by EFAs in European agricultural landscapes.

Habitat thresholds for forest biodiversity as recommendation for managers in Europe

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The enhancement and conservation of forest biodiversity requires sustainable strategies for the preservation and management of specific species' habitats. The restoration or maintenance of forest habitats is also required by international and national agreements and regulations. These include several structural indicators which are used as proxies of biodiversity or management sustainability. However, these indicators were never directly tested with multi-taxon forest biodiversity across wide extents. Here we aim at designing sustainable management indicators for maintaining and enhancing habitat biodiversity. For this we use a threshold approach to identify tipping points where the management indicators have a distinctly higher effect on multiple taxa or single taxon biodiversity. This is enabled by the launch of a novel database implemented by the COST Action Bottoms-up that includes multi-taxon biodiversity, structure and management information from more than 3,000 plots across Europe. We hypothesize that common management indicators that relate to a wide range of niches and link to various species may show distinct thresholds for promoting biodiversity while, at the same time, we have an array of different points for specific taxonomic groups or indicator species. This approach should allow for specific management recommendations towards overall biodiversity and particular groups or single taxa.

Effects of ivermectin use on dung beetle communities: Lasting decrease in functionality and richness

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Use of ivermectin negatively affects non-target dung beetles, which provide keystone ecosystem services for pasture functioning. Direct effects of ivermectin on dung beetles are well understood, but its long-lasting effects on real communities under field conditions remain unknown. We studied species richness, abundance, biomass

and functionality (composition-mediated dung removal ability) of dung beetle communities in response to ivermectin treatment. Selected 15 ivermectin-treated and 11 untreated sites, both ≥ 5 consecutive years before sampling, covered wide range of climatic conditions in the Czech Republic, seasonal variability, and main herbivore dung types. Ivermectin-treated sites we selected into i) recently treated < 8 weeks ago (immediate effects, lethal-sublethal residues levels) and ii) long-ago > 8 weeks (lasting effects, sublethal to inconsequential residues levels). Ivermectin-treated sites had 35% lower species richness and 44% lower abundance, biomass did not change. From a functional perspective, ivermectin use significantly decreased the biomass of beetles with high contribution to dung removal (relocators, dwellers), while the biomass of beetles with low contribution (visiting adults, saprophagous larvae) was unaffected. Functionality, i.e., the dung removal ability of the community, was significantly reduced at treated sites. Effects of ivermectin use far beyond its physical presence have obvious negative consequences for pasture biodiversity and ecosystem functioning.

High resolution ALS-derived forest structure explains ecomorphological trait variation in assemblages of wood-living beetles

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Global climate change is rapidly altering the complex 3D structure of forests, which is a major habitat determinant affecting local communities. However, little is known about how functionally diverse wood-living (saproxylic) beetles, involved in the recycling of wood, will be affected by this change. Here we combine ecological and morphological traits available for saproxylic beetles and airborne laser scanning (ALS) data in Bayesian trait-based joint species distribution models to study how traits drive the distributions of more than 230 species in temperate forests of Europe. We found that elevation (as a proxy for temperature and precipitation) and the proportion of conifers played important roles in species occurrences while variables related to habitat heterogeneity were less relevant. Further, we showed that local communities were shaped by environmental variation through their traits. As predicted, ecological traits shaped species' responses to forest structure more than did morphological traits. Both models, however, revealed strong phylogenetic signal in species' response to environmental characteristics. Our findings provide support that strong habitat filtering based on evolutionary adaptations is a central process shaping saproxylic beetle communities. Therefore, future changes in climate and the forest structure may influence ecosystem functions by altering community trait composition.

Evaluating policy outcomes in complex land-use systems

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To inform the design of policies that effectively reach sustainable development goals, reliable knowledge about both the status quo and potential pathways of transition is required. A comprehensive evidence-based policy advice thus needs to capture dynamics of complex socio-ecological systems, including biophysical mechanisms and diverse human-nature relationships. We present a conceptual framework for a transdisciplinary, co-productive approach for evaluating outcomes of land-use governance through an integrated policy assessment. The case of Nordic forest policies is used to elaborate on the role of theory, model integration, and knowledge co-production. Here, we argue that three main components are needed: 1) a comprehensive theory about causal mechanisms in the system, 2) a modular architecture that operationalizes data flows between various models, and 3) a procedure to integrate values and knowledge from multiple stakeholders. The general idea of such a modular model architecture for integrated policy assessments can in principle be applied to any land use policy nexus.

Nordic forest governance shifts towards multi-functionality and non-regulatory approaches

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Forests are rising on the global political agenda as key ecosystems for mitigating climate change and halting biodiversity loss. Fenno-Scandinavian countries are among the largest exporters of forest-based products and their forest management is thus of strategic importance for (inter-)national forest policies. Based on a "most-similar systems" study design and expert-based interviews, we compare the development of forest policy instruments across Denmark, Finland, Norway, and Sweden over the last 20 years. Analytically, we place an emphasis on paradigmatic shifts in goals, instruments, and governance modes while considering (un)intended consequences and effectiveness. We find an increasing use of non-regulatory instruments, and a broadening of goals from economic production to climate objectives, as well as biodiversity conservation, and thus a moderate shift toward multi-functionality. There are differences in the timing of introducing economic policies and in the use of participatory processes. We discuss these differences with regard to the policy outcomes and in the light of multi-level forest policies in the European Union. Here, we argue that the design of effective multi-functional forest policies benefits from an early inclusion of a broad range of stakeholders, especially when coupled with processes that allow for a re-negotiation of roles and positions.

Diverse opportunities for grassland biodiversity in agricultural and urban landscapes

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Grasslands occupy large areas in agricultural and urban landscapes. Although considered to be species-rich habitats, the response of their biodiversity to landscape structure has been much less studied than for wooded habitats. Here we investigated multi-taxon responses of grassland biodiversity to landscape structure across a single region and compared these between agricultural and urban contexts. Plant, carabid, and bird communities were sampled along landscape gradients in agricultural and urban contexts, in western France. We looked at the influence of grassland connectivity and proximity with wooded

habitats and private gardens on species richness and composition of overall communities and of functional groups. Results showed that species richness did not vary much according to landscape structure while species composition did, governed by ecological traits. Species and functional composition also differed between agricultural and urban contexts. Biodiversity of grasslands in both agricultural and urban contexts was primarily influenced by neighbouring wooded vegetation at different scales. In urban context, a high proportion of private gardens correlated with increased plant species richness and bird abundance in grasslands and influenced species composition. We conclude that grasslands located in differing landscape contexts offer diverse opportunities for biodiversity.

Breeding birds in European Agroforestry systems

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Declining numbers of farmland birds across Europe call for drastic changes in agricultural systems. Agroforestry could be such a change by mixing open farmland elements with trees. In the EU AGROMIX project, we study mature agroforestry systems combining either trees and crops or trees and livestock grazing. We compare biodiversity of the agroforestry system with its components, such as crop monocultures or tree plantations. Here, we present first results regarding breeding birds in agroforestry systems in temperate Europe, with sampling sites in England, Switzerland, France and Germany. Breeding birds were assessed with audio recordings. Preliminary analyses suggest that species richness in agroforestry is comparable to forest, but higher than in orchard, grassland and arable controls. However, agroforestry had different species composition than forest, including species that depend on semi-open habitats. Thus, integrating agroforestry into agricultural landscapes could greatly enhance bird populations.

Conserving bee diversity in gardens through vegetation and nesting resources across urban landscapes

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In cities, insect pollinators contribute to urban biodiversity and provide important ecosystem services including pollination. Urban gardens are social-ecological spaces where wild and cultivated plants coexist, and natural structures are implemented or remain. Through these habitat interventions in what may otherwise be a resource-poor landscape, gardens may support diverse pollinator assemblages. In this talk, I use the example of our research on wild bees in community gardens in Berlin and Munich, Germany, and the California Central Coast, USA, to discuss how these habitats can promote bee assemblages representing a wide range of life history strategies. Specifically, I show how functional traits of bees associate with management factors in gardens, and also how bee traits relate to landscape-level urbanization. Furthermore, I consider how findings of rare bee species in these gardens open questions around whether gardens in urbanizing landscapes are ecological sinks, or whether they can support species conservation. Although many mechanisms driving urban pollinator diversity remain unknown, our preliminary work on bee diversity and traits in relation to the urban environment provides practical insight into how city residents can actively contribute to pollinator conservation, and calls for future research on changes in pollinator diversity in cities.

Land sharing in urban gardens to support insect biodiversity

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Urban gardens are a form of green infrastructure that engender a range of ecosystem services, such as food production and recreation. These systems can also be biodiversity hotspots of animals and plants through a mix of annual and perennial vegetation and structural diversity and complexity. Yet, sometimes urban gardens are posed as 'at odds' with biodiversity if human aesthetic preferences and benefits are preferred over nature conservation objectives. In this talk, I discuss how community gardens are a form of urban green infrastructure that can reconcile conflicts between biodiversity conservation and human use. I present examples of how through management of diverse cultivated and wild plant communities in these systems, we can also thereby promote arthropod biodiversity, such as of wild bees. As urban community gardens are a form of urban green infrastructure that is consistently threatened and erased from our cityscapes, this work aims to prompt discussion around the value of these shared spaces for people and biodiversity.

Ecosystem service valuation as argument for wetland restoration

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Policy makers and businesses are still regarding nature restoration and protected areas management as a cost, not as an investment that is generating values. The paper outlines monetary valuation of the fish and biomass provisioning ecosystem service from restoration investments in protected areas Persina Island, Kalimok and Kalkusha wetlands in Bulgaria. The results are as follows: the increased water supply of the areas contributed to the enhancement of carp nursery habitats, resulting in increased adult carp landings for local fishermen while the potential biomass provisioning services – palletization of harvested reed and use as fuel – also increased. This example is compared to ecosystem service assessments for selected floodplains along the rivers Tisza in Hungary and the floodplain community Bistret in Romania on the Lower Danube, both candidates for restoration measures. The feasibility of market utilization of these ecosystem services and their implications to water management and climate change adaptation policies and implementations are discussed and evaluated.

Tracking the social dimension of ongoing fish distributional range shift in marine recreational fishing

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One of the most important ecological impacts of climate change on marine ecosystems is the distributional range shift of species. Understanding the social implications of this phenomenon is crucial for managers and policymakers for developing effective and proactive adaptive management. Here, we characterize the social dimension of recreational fishing by mining data on YouTube about recreational anglers and spearfishers targeting the white grouper (*Epinephelus aeneus*), which is expanding northwards in the North-Western Mediterranean Sea. Results showed that social engagement in Italian videos is higher for spearfishers than anglers. We also found a higher positive polarity and positive emotions in spearfishing comments compared to angling comments. Most importantly, we detected a geographical gradient of emotions showing a positive correlation between the emotion "joy" and latitude. This result suggests that videos from higher latitudes, where the white grouper is still a rare species, triggered more joy than at lower latitudes where this species is more common. We demonstrated the potential of social media data for quantifying socio-ecological dynamics across a geographical gradient and, above all, the possibility for real-time monitoring of the social dimension associated with biodiversity redistribution in response to climate change.

Balancing conservation and production in the bioeconomy: stakeholder-based management scenarios make biodiversity winners and losers in the boreal forest

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Countries are transferring into fossil-free economies with increasing demands on woody products. This makes a rigorous process identifying policy instruments that reconcile wood production and biodiversity conservation ever more important. Land-use policies that are founded in the expertise and particular interests of key stakeholders are likely more implementable and politically long-lasting, however, only if a common perception about the future exists. In this study, we simulate the development of a >100000 ha Swedish forest landscape 100 years into the future, based on the management and policy scenarios of four key stakeholders. We based simulations on state-of-the-art models for eleven species of conservation concern. The simulations show that most species do as well or better as today after 100 years under all but the most production-oriented scenario (formulated by Swedish landowners). For wood-decaying fungi, the percentage forest not managed with even-aged forestry was the common denominator for this result. Birds and the lichen *Lobaria pulmonaria* showed stable or positive developments on all management types. The scenario presented by the state-owned forestry company was the most production-oriented scenario, which still largely sustained biodiversity after 100 years. The species generally increased in the scenarios by the Sweden's EPA and largest environmental NGO.

N = 2 (×5). An attempt to compare effects of feral horse refaunation on five checkerspot butterfly species inhabiting dry grasslands of Podyjí National Park.

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Restoring natural habitats by native megaherbivores refaunation is increasingly practiced across Europe, but very little is known regarding population dynamics of affected biota, including insects. To fill this gap in knowledge, we used mark-recapture to compare demography, dispersal and habitat utilization by five Melitaeini butterflies (*Melitaea athalia*, *M. aurelia*, *M. britomartis*, *M. cinxia* and *M. didyma*) co-occurring at grasslands of Podyjí National Park, Czech Republic, refaunated by Exmoor ponies. Both pre-(2017) and post-(2021) intervention surveys encompassed whole-season field work, amassing huge amount of material (e.g., total of 17,100 capture events). Still, the post-intervention findings differed in many ways from our pre-intervention predictions (J. Nature Conserv. 52, 125755), pointing to substantial variation among years due to such factors as weather. Findings attributable to the megaherbivores presence included longer butterfly movements and more uniform within-habitat distribution, probably because the horses uniformized the distribution of their resources. Encouragingly, the critically endangered *M. britomartis*, rarest of the five butterflies, benefited from the refaunation. Despite all the effort, two seasons can hardly grasp entire dynamics of a system, in which large mammals, vegetation, insects, and inter-annual weather variation interact.

Anthropogenic barriers affect large carnivore range expansion in Iberia

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Large carnivores currently recolonise their historical range in Europe after centuries of persecution and habitat loss. Understanding how these recolonisations take place is important for proactive conservation planning to foster coexistence between carnivores and people. Integrating species distributions models with dispersal scenarios, we explore where and when large carnivores are likely to expand into human-dominated landscapes, and how human pressure might impact this recolonisation process.

We highlight that the recolonization potential of large carnivores in the Iberian Peninsula is likely more constrained by anthropogenic resistance than by habitat availability, a situation likely emblematic of large carnivores in many parts of the world. More generally, our approach provides a tool for conservation planners and managers to identify where range expansion is most likely to occur, and thus where human-carnivore conflicts could arise, to proactively implement preventive measures that foster coexistence between humans and wildlife.

Using a novel biodiversity data standard and platform to mainstream the Essential Biodiversity Variables

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The ambition of NaturaConnect is to co-create with key decision-makers and stakeholders, knowledge, tools and capacity building to support Member States in realizing an ecologically representative, resilient and well-connected network of conserved areas that contribute to achieving the objectives of the EU Biodiversity Strategy for 2030. To do this, NaturaConnect has a comprehensive set of interdisciplinary research tasks aimed at producing, sharing and mobilizing knowledge for implementation. This includes applying state-of-the-art models on the distribution of biodiversity and ecosystem services across Europe and scenario projections on how distributions may change under future climate and land-use scenarios. Essential Biodiversity Variables are the cornerstone for assessing gaps in the current protected area coverage and to identify critical ecological corridors required to restore connectivity.

Biodiversity monitoring to support the Birds, Habitats, and Water Framework Directives

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Enhanced data workflows and models can leverage monitoring data on biodiversity and potential drivers to assess the status of selected terrestrial and aquatic habitats and species of the Nature Directives. Furthermore, regulatory monitoring under the Water Framework Directive can serve as the backbone for better integrated aquatic biodiversity monitoring in Europe. By integrating multiple data sources including remote sensing, coordinated monitoring programs, and citizen science, we propose ways in which data workflows under the European Nature Directives can be effectively enhanced. Ensuring production and distribution of Essential Biodiversity Variables data is key for supporting comprehensive and coherent monitoring within Europe.

Sustaining traditional knowledge systems for better environmental stewardship

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Over the last decades, significant knowledge has accumulated about the unique contributions of Indigenous Peoples and local communities to global biodiversity conservation. As a result of this rich body of evidence, there is increasing recognition in policy circles that traditional knowledge systems play critical roles in safeguarding our planet's biological and cultural diversity. However, globalization, colonialism, and extractivism threaten the integral relationships between Indigenous Peoples and local communities and their environments, thereby challenging the continuity and resilience of their knowledge systems. Based on my long-term field-based research partnerships with several Indigenous communities in the Global South (e.g., Tsimane' in Bolivia, Maasai and Daasanach in Kenya) and drawing on an in-depth global literature review on pressures to traditional knowledge systems, this work will identify 15 strategic actions to support the ongoing efforts of Indigenous Peoples and local communities in sustaining their knowledge systems and ties to lands. I will finally discuss how supporting Indigenous Peoples and local communities in sustaining their homelands and associated knowledge systems is inextricably linked to global efforts to address biodiversity loss and climate change.

Mass-flowering crops as a pollinator biodiversity enhancing intervention

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Biodiversity conservation in agricultural landscapes is often restricted by the surface of productive land. A promising way to circumvent this problem, is when crop cultivation in itself also benefits biodiversity. For example, mass-flowering crops temporally provide enormous amounts of food resources for insect pollinators, potentially boosting local biodiversity levels. However, placement of honeybee hives is frequently deemed necessary for high yields, potentially offsetting some of the biodiversity benefits of mass-flowering crop cultivation. In this case study, we have studied the contribution of buckwheat (*Fagopyrum esculentum*) cultivation to wild pollinators and vice versa, and whether the placement of honeybee hives influences wild pollinators. We found that the buckwheat pollinator community was diverse, albeit dominated by honeybees, and we found no clear indications of resource competition between honeybees and wild pollinators. Crop yield was largely dependent on crop pollinator density, notably of honeybees, and to a lesser extent crop biomass. Also when the honeybee hives were removed, relatively large densities of honeybees were found, suggesting that they lure honeybees away from natural areas. Our results indicate that buckwheat cultivation can contribute to fill an important nectar gap in the summer, which potentially increases wild pollinator populations on the long term.

Halting the Loss of Biodiversity in the European Union; the Effect of the Environmental Liability Directive

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In 2004, the Environmental Liability Directive (2004/35/EC; ELD) introduced liability for preventing and remediating biodiversity damage, that is, damage to species and natural habitats protected by the Birds Directive (2009/147/EC) and the Habitats Directive (92/43/EEC). Whilst the ELD also introduced liability for preventing and remediating land and water damage, its main focus is to assist in halting the loss of biodiversity in the EU. Before introduction of the ELD, no Member State imposed liability on persons whose activities had caused biodiversity damage to carry out measures to compensate for the failure fully to restore it or for the loss of biodiversity during the time it was being restored. Indeed, many Member States did not require biodiversity to be restored to its condition before it was damaged. The ELD has now been in force for over 12 years. During this time, the European Commission and Member States have carried out measures to improve its implementation including its assistance in halting the loss

of biodiversity. The purpose of this paper is to examine the extent to which they have been successful.

Downscaling the fulfillment of global climate targets to national and landscape level harvest projections and biodiversity assessments

Forsell N¹

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During the last decade, a large body of work has been done to define cross-sectoral mitigation pathways at the global and regional levels that are consistent with reaching the Paris Agreement's goal of limiting global warming to well below 2 °C, preferably to 1.5 °C, compared to pre-industrial levels. Analysis has highlighted the critical role forests and land use sectors will play in pathways that are aligned with 1.5 °C and 2 °C temperature targets. However, there is less understanding of what the global and regional pathways mean for national and landscape level development. The aim of this work is to demonstrate how global greenhouse gas (GHG) reduction pathways can be downscaled and translated to future national- and landscape-level forecasts of wood demand. The GLOBIOM-forest model (a global spatially explicit forest sector model), which here is used to project the future demand for wood, which in turn can then be coupled with highly detailed national forest planning tools to analyze the multiple dimensions of biodiversity and ecosystem services at the national and landscape scale.

Calling for a re-assessment of conservation policy on hybrids

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The IUCN currently considers hybrids as a threat to biodiversity conservation. Hybridization with an invasive or feral population/species can negatively affect resident taxa by genetic swamping and homogenization. Moreover, population viability can be compounded by outbreeding depression (also in later generations) and/or lead to the loss of genetic diversity. Yet hybridization is omni-present and can play an important role in evolutionary processes such as speciation. Furthermore, interspecific genetic exchange is a natural process and may be essential for adaptation. Hence, we need to consider and manage hybrids in a more nuanced way. Here, under the initiative of the IUCN SSC Conservation Genetics Specialist Group, we discuss different aspects of hybridization, taking into account risks and benefits of hybrids, including the specifics of taxa, the level of threat, the population size, the distinction between human induced versus natural hybrids, besides legal, welfare and functional ecological aspects. We argue that genetic analyses increase our ability to discover introgression and identify hybrids, allowing us to better assess, monitor and manage genetic diversity, which is critically important for the resilience of populations and ecosystems. If introgression can ensure or improve retention of unique genetic components without reducing population viability, hybrids may warrant preservation.

Public judgment of rewilding in relation to different views of animal welfare

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Rewilding is enjoying growing traction in conservation biology and is now receiving considerable public attention. In this paper, we will focus on a specific form of rewilding, 'translocation rewilding', in a Dan-

ish context. Here, domesticated larger grazing animals such as horses and cattle are settled in new so-called National Nature Parks (NNP), which are fenced areas of 5–30 km², to facilitate improvements to the ecosystem. Supplementary feeding is not practised, but animals can be taken out. Two questions in relation to the case are explored: how are the animals translocated to the area viewed: as wild, tame or something in between? What aspects of animal welfare are considered important, and how does this influence an overall judgment of NNP and translocation rewilding? Debates between supporters (e.g. conservation biologists) and opponents (e.g. veterinarians) of NNPs have become harsh and rather intractable. We suggest that two underlying causes of disagreement are, first, a stress on different aspects of animal welfare (e.g. absence of suffering vs natural living) and assessing animals at different levels (e.g. individual vs herd level). We inform the discussion by drawing on a study of where the Danish population stands on these issues, using a representative sample, (n=5000).

Is Vacant Land a Valuable Habitat for Urban Bees?

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Although we see rapid urbanization occurring across the globe, over 400 cities worldwide have lost substantial population. These "shrinking cities" are tasked with demolishing an overabundance of unneeded infrastructure, creating parcels of vacant land. A recent focus on vacant land as a conservation target is justifiable as many rare or declining bee species have been documented within these urban greenspaces. In fact, a remarkable 20% of Ohio's (USA) bee fauna have been collected from urban vacant lots. However, for pollinator conservation to succeed long term, far greater consideration for the humans in urban ecosystems must be made. In our experience, conservation potential is difficult to achieve when conservation goals, aesthetics, and safety concerns are not shared or communicated between city residents and conservation practitioners. Likewise, from a bee ecology perspective, many questions remain unresolved regarding optimal design and management practices for pollinator habitats in cities. This presentation will discuss these challenges to urban bees and suggest ways to advance effective pollinator conservation paired with the delivery of cultural ecosystems services within vacant land and other forms of public greenspace.

Assessing the impact of protected areas on biodiversity and the role of experimental design

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In this talk, I will examine the role of study design and the quality of data on the ability to assess effectiveness and impacts of protected areas. Protected and conserved areas are enshrined in the Convention on Biological Diversity and are amongst the most important tools for safeguarding nature. This had led to a proliferation of sites under formal or informal protection with more than 250,000 sites now designated across the globe and covering over 15% of the terrestrial surface. However, to what extent these protected areas are having an impact and are effective in delivering positive conservation outcomes is debated. Addressing this question has proven difficult for at least two interconnected reasons. One; lack of data on changes in the state of nature, and two; difficulties with implementing experimental setup at scale or applying appropriate quasi-experimental methods on the data available. In this talk, I will examine the experiences from published studies and synthesis of the effectiveness of protected areas at the global and regional levels, to explore how increasingly sophisticated statistical methods and better data have changed our perception of the impact and effectiveness of protected areas.

Temperature drives wild bee community assembly in an urban environment

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Urbanization is widely regarded as a major threat to biodiversity. However, recent research highlighted the ecological importance of cities for pollinators. Key determinants of cities' ability to sustain pollinators are the amount and the spatial organisation of green areas. In addition, temperature is expected to be of primary importance for pollinator activities. Here, we aimed at disentangling the effects of temperature, open habitat cover and distance from the city centre on wild bee communities in the city of Rome (Italy). We selected 36 sites along two independent gradients of surface temperatures and of open habitat, and we sampled bee communities using pan traps for four months. Then, we measured functional traits of wild bees, i.e., body size, social behaviour, nesting strategy, and diet breadth. Temperature emerged as the main driver of wild bee communities. At warmer temperatures, communities were richer in species and individuals. In addition, with increasing temperatures, bee communities showed a higher percentage of polylectic and small size species. Here, we showed that in a highly urbanised environment, temperature shapes pollinator communities irrespective of other landscape metrics. Warming seemed beneficial for bee abundance, but it might homogenise communities selecting for those traits that make species more easily adaptable.

Anthropogenic resistance – considering human-wildlife conflict in conservation planning

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Landscapes around the globe are increasingly transforming due, in part, to increased human population, expansion and intensification of land uses, and infrastructure development. This transformation forces megafauna to share landscapes with people and to venture into human-dominated areas when moving between habitat patches. Sharing landscapes can lead to competition over space and resources, and negative outcomes (e.g., conflict) for both species. Despite landscape-level conservation efforts, including the protection of core habitat and movement corridors, conflict continues to threaten megafauna worldwide. We argue that the growth of conflict despite conservation efforts arises from ignoring the diverse human behaviours that influence wildlife movements and persistence. Thus, we introduce the concept of 'anthropogenic resistance' to capture the psychological and socioeconomic factors that shape human behaviours and wildlife outcomes. Several factors such as the risks posed by a species to the high economic-value property could influence the responses of humans to megafauna presence and related conflict. We illustrate the concept of anthropogenic resistance using case studies and propose how to obtain and incorporate data into conservation planning. A more holistic social-ecological perspective in conservation planning can help to ensure the coexistence of people and megafauna.

The impact of forests characteristics on forest recreational value – an European perspective

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The economic value of goods and services provided to the societies by forests depends on how forests are managed. On a European scale, forests are diverse and managed in many ways. Yet, there has been no large-scale assessment of the economic value of forests recreation across Europe. In this paper we systematically apply preference-based valuation methods to investigate public preferences for forest visits in ten European countries. We observe substantial recreational value measured by the consumer surplus. Compared to the gross value added of forestry and timber production, gross recre-

ational benefits are, except for Belarus, on par or larger. Additionally, using stated preference methodology we find that more diverse forest structure with taller trees, a larger number of mixed tree species, higher variation in tree layers, and larger amounts of deadwood yield, on average, higher recreational values. This implies that managing forests to promote recreational values may generate significant synergies with biodiversity conservation. The results of our study provide a robust basis for evaluating the societal consequences of future forest management policies and can form a basis for integrating forest recreational values into ecosystem service models for European forests. An example of such analysis is performed for Poland.

Coexisting with different human-wildlife coexistence perspectives

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Over the last decade, there has been a remarkable increase in scientific literature addressing human-wildlife interactions (HWI) and associated concepts, such as coexistence, tolerance, and acceptance. Despite increased attention, these terms are rarely defined or consistently applied across publications. Indeed, the meaning of these concepts, especially coexistence, is frequently assumed and left for the reader to interpret, making it hard to compare studies, test metrics, and build upon previous HWI research. To work toward a better understanding of these terms, we conducted two World Café sessions at international conferences in Namibia, Africa and Ontario, Canada. Here, we present the array of perspectives revealed in the workshops and build upon these results to describe the meaning of coexistence as currently applied by conservation scientists and practitioners. Although we focus on coexistence, it is imperative to understand the term in relation to tolerance and acceptance, as in many cases these latter terms are used to express, measure, or define coexistence. Drawing on these findings, we discuss whether a common definition of these terms is possible and how the conservation field might move toward clarifying and operationalizing the concept of human-wildlife coexistence.

What factors drive arthropod communities on extensive green roofs of Central Argentina?

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Green roofs are among the recommended green infrastructures to support biodiversity in cities, where impervious surfaces, pollution, and warming jeopardize wildlife. However, the effectiveness of green roofs to provide habitat for arthropods is still poorly known, particularly for Latin American cities. Therefore, we investigated how different structural and environmental characteristics of extensive green roofs influence flying and ground-dwelling arthropod communities. We collected arthropods using yellow pan traps and pitfall traps in 30 green roofs located in different urbanization contexts in Córdoba, Argentina. In addition, a subset of green roofs was compared to their neighbour ground-level habitats. Despite that green roofs supported, on average, half the diversity and abundance of ground-level habitats, we found diverse communities on green roofs, with more than 600 morphospecies and 20,000 individuals. Flying arthropods were mainly positively linked to green roof area and variables such as green cover in the landscape and plant richness. In contrast, ground-dwelling arthropods were affected by plant composition, and their abundance and richness increased with irrigation and soil depth. These results represent the first assessments of arthropods on green roofs of a Latin American region and provide valuable information to guide the design of biodiverse green roofs.

Field defects in oilseed rape: a promising alternative for insect conservation in arable fields?

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Biodiversity has decreased globally and agricultural intensification is one of the main causes. Therefore, conservation measures in agro-ecosystems are urgently necessary. Over the last years, we investigated natural and artificially-created temporary patches of non-crop habitats (field defects) in oilseed rape fields in the Czech Republic and assessed their effect on arthropod communities and ecosystem services. Natural field defects supported fewer species of carabid beetles than oilseed rape controls, whereas pest and weed seed predation levels were similar or slightly lower in defects compared to controls. In artificial defects, Lepidoptera, Hemiptera and Hymenoptera were more abundant and diverse than in controls, while the abundance of spiders showed the same trend. On the contrary, carabids and staphylinids presented more individuals and species in the controls, and the richness of myriapods showed the same pattern. In both natural and artificial field defects, abundance and richness increased during oilseed senescence, when field defects seem to become suitable refuges for several groups. These temporary patches may represent a simple tool to benefit some groups of arthropods, although future studies are needed to better understand their importance in terms of ecosystem services and how they will perform when established in low-yield areas of cultivated fields.

Contextualizing Fish Habitat in Novel Riverscapes

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Current trends in freshwater fish biodiversity on a global scale are showing continuous decline. Many of these degraded ecosystems are lotic systems that currently exhibit hybrid ecosystem states and can be restored to similar historical conditions prior to anthropogenic pressures. Other rivers exhibit novel ecosystem characteristics where no amount of restoration could return it to its former state. A greater understanding of fish-habitat relationships is needed comprehensively to identify realistic conservation opportunities in this context. Relatively few fish-habitat models integrate a novel ecosystems perspective thus conservation goals may misalign with biological and practical limitations throughout the river restoration process. Past literature highlights how current models often fail to 1) encompass the long time scales that operate on altered lotic systems, 2) account for hydrologic complexity, 3) incorporate diverse fish movement patterns, and 4) evaluate multiple disturbances simultaneously. Herein we propose a new perspective of altered rivers and the implications this has for fish habitat modeling. We focus on these challenges both historically, present time, and their future outlook. We provide a spatial and temporal overview of how new developments in fish-habitat models can be guided to better address novel river ecosystems.

Moving tracks across socio-scapes

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Wildlife move through and within complex environments. Traditional assessments of external factors governing movement characteristics focused largely on biophysical attributes. But with an increasingly crowded planet, its crucial to also evaluate of socio-scapes comprised on human behaviors, cultures, values, and governance schemes that create heterogeneous, dynamic environment that organisms must also navigate. How humans interact with the natural world can create barriers to movement and reduce connectivity, alter habitat quality that result in avoidance, and produce areas of high risks. Additionally, humans can be recipients of provisioning and biocultural services associated with the movement of animals. For example, pulsed resources made available during migratory routes are beneficial for indigenous communities and the local tourism industry. However, disease

exposure and human-wildlife conflict also emerge from movement patterns. These feedbacks with humans as drivers and humans as recipients highlight the need in building infrastructure to explicitly incorporate social dimensions into animal movement ecology. Only by coupling databases of social and natural processes and investing in technologies that gather both types of information will we have the tools necessary to promote coexistence for a sustainable future.

Landscape-scale agri-environment schemes in social-ecological systems for promoting pollinators

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Biodiversity in agro-ecosystems is decreasing rapidly in Europe despite the implementation of agri-environment schemes (AES). AES at landscape scale have been suggested to be more effective than measures by individual farmers. However, effects of landscape scale AES on ecological, social and economic outcomes remain poorly understood including how different AES in the landscape affect pollinators.

We identified potential synergies of implementing cooperative AES at the landscape scale between ecological, social and economic aspects. The cooperation of farmers and other stakeholders could lead to increased ecological effectiveness and ecosystem services, but also higher social capital. Moreover, cooperation might result in decreased transaction costs and improved market opportunities for farmers.

First results of a field study showed interactive effects of two AES at the landscape scale on wild bee abundance: Increasing area of annual flower fields only had a positive effect, if the proportion of organic farming was low. However, the effectiveness of organic farming depended on the availability of semi-natural habitats providing nesting habitats.

AES implementation at the landscape scale is a promising tool with potential to overcome the currently low effectiveness of AES in halting biodiversity decline. Nevertheless, key questions remain unsolved and interactions between different AES should be considered.

The effects of river floodplain restoration on ecosystem services

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Rivers and their floodplains are recognized to support vital ecosystem functions and services at local and regional scales. Restoration measures of floodplains, may aim to re-establish multi-functionality of floodplain systems, by ensuring navigation, preserving and restoring unique fluvial and riparian habitats, re-establishing natural processes and hence, to support a variety of service provisioning. Different restoration measures can be implemented including side arm re-connection and more in-channel measures such as the removal of embankments and groins. We present ecosystem services in river-floodplains and evaluate how a programme of measures along the Danube can influence the diversity and quantity of specific ecosystem services (ES) and therefore, the overall multi-functionality of floodplains compared to the current situation. Therefore, regulating ecosystem services (RES), such as nutrient retention and habitat provisioning, were modeled and predicted. Also, the potential to provide cultural ecosystem services (CES) was assessed based on mapping of various land- and water-based recreational activities. We present results showing synergistic effects and potential tradeoffs for different ecosystem services related to restoration measures. Overall, we provide evidence that restoration measures have a high potential to increase the multi-functionality of the floodplain system by supporting the provisioning of RES including habitat availability and selected CES.

Wildlife movement management frameworks in conservation of social ecological systems

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Movement of organisms is one of the key mechanisms determining individual responses to resources, environmental change and species interactions, patterns of changes in species' traits and genetic diversity, and, ultimately, the distribution of biodiversity (Brose et al. 2004; Nathan et al. 2008). Movement is therefore fundamental for predicting human impact on biodiversity, e.g. in the context of changes in landscape configuration, habitat deterioration and climate change (Jeltsch et al. 2013). Recent technological advancements certainly provide big data on movement patterns of unprecedented quality, but a key challenge now is to make full use of such data with regard to better understanding and predicting biodiversity dynamics and how to make the outputs readily accessible and integrated, i.e. how to communicate them in an understandable way to conservation practitioners (Barton et al. 2015; Fraser et al. 2018). The importance of understanding the patterns and drivers of movement for effective conservation and management has been recognized (Katzner and Arlettaz 2020), there is, additionally, often a disjoint in aims and goals of researchers and managers in conservation science and movement ecology. We aim to tackle the gaps in understanding between aims of conservation practitioners and researchers, and in how science-based findings in movement ecology may refine decision-making and thus contribute to fulfilling conservation objectives. We therefore invite practitioners and scientists from both fields to a debate on joint and transdisciplinary approaches for effective conservation in the Anthropocene.

Spatial prioritisation of threat management for biodiversity conservation across the Natura 2000 network

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Effective conservation must rely on careful planning and strategic investment of limited resources. The last report on the State of the Nature in the European Union (EU), a periodic monitoring exercise at continental scale, shows that biodiversity continues to decline, despite the efforts done in the last decades. Urgent action is, therefore, needed to reverse this trend.

We carried out a gap analysis to identify pressures and threats with no reported management action over the period 2013–2018 and identify priorities to close this gap. We finally prioritised the selection of pressures and threats to be addressed for all species and habitats collectively, to identify management priorities.

We found that 2/3 of all combinations of species/ habitat x pressure/ threat did not have management actions reported. Management gaps were especially large for birds, amphibians and reptiles and marine bioregions in northern EU. The spatial prioritisation analyses showed that all species and habitats could benefit collectively from a reduction in 30% of pressures/ threats incidence by targeting a small proportion of pressures/ threats and Natura 2000 sites.

The prioritisation approach that we demonstrate here could be valuable to plan investment to close the current management gap and inform conservation across the EU.

The application gap: genomics for ecosystem service management

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The conservation of biodiversity at all levels is fundamental for the continual provision of ecosystem services, ES. This is because biodiversity underpins ecosystem functions and services and enables the resilience of populations, services and communities in the face of uncertainty. Genetic and genomic diversity information is now increasingly used in applied biodiversity conservation thanks to the implementation of solutions to bridge the “conservation genetics gap”. We argue that a similar “application gap” exists for genetic and genomic information in natural resource management for ecosystem services. We review evidence on how genomic applications can be used to support management goals for ES through dedicated management actions based on genomic information in single species (relatedness, neutral vs. potentially adaptive variants) or in interacting species (host-microorganism coevolution, hybridization). These goals pertain to conservation and restoration questions, but also to the production of food and materials in ecosystems managed for sustainable productivity, to adaptive management in the face of climate change, to the management of invasive species and to the management of microbial diversity and functions to support ES from soils and potentially even oceans. We provide examples of management applications when available, and conclude with perspectives on genomics for ES.

Introducing the G-BiKE

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The COST Action G-BiKE (Genomic Biodiversity Knowledge for Resilient Ecosystems) includes more than 110 researchers and practitioners from all European countries. G-BiKE's goal is to install measuring and monitoring of genetic diversity in any new policy and regulation targeting biodiversity. G-BiKE's activities –from workshops to small grants– are ultimately intended to ensure persistence of populations and species, and to guarantee the supply of nature-based ecosystem services. Our main aims are: 1) explaining how genetic diversity can support ecosystems; 2) developing and testing best practices for monitoring genetic diversity in time and space; 3) providing an online forum on emerging tools; 4) connecting all stakeholders through networking and training opportunities; 5) building a network of conservation genetics labs. G-BiKE is actively involved in the drafting of the post-2020 Global Biodiversity Framework (GBF) of the Convention of Biological Diversity. Through several papers, webinars and policy briefs G-BiKE managed to propose some amendments to the zero draft that resulted in the current inclusion of genetic diversity in the new targets. Finally, G-BiKE is among the founders of The Coalition for Conservation Genetics, a network of networks.

Our (Traditional) Knowledge Our Way?

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Traditional knowledge of herders, foragers and farmers is increasingly recognised as useful for conservation science, policy and practice across Europe. However, few conservation scientists are trained to work with place-based knowledge, practices and worldviews. European guidelines for ethical research practice are generally silent on these topics. Some journals contain standards for working with Indigenous knowledge, generally drawn from experiences in places such as Australia and Canada. Many challenges have been encountered in working with traditional knowledge in these contexts—knowledge is frequently misappropriated for commercial gain without benefits flowing to communities, without consent and in ways that are considered harmful by traditional custodians. Here I present guidance about working with traditional knowledge in biodiversity assessment, emanating globally from the Intergovernmental Platform on Biodiversity and Ecosystem Services, and nationally from Australian Indigenous land and sea managers in Our Knowledge Our Way and the recent State of the Environment 2021 report. Australian Indigenous peoples emphasise their own purposes and leadership in traditional knowledge, rather than situating these in the context of enrichment of scientific-led biodiversity management. I consider whether these guidelines may be applicable in the European context, and how conservation scientists can use such guidance to enrich their research and practice.

Patterns of taxonomic, functional, and phylogenetic diversity in forest–grassland mosaics

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Large areas of Eastern Europe are covered by forest–grassland mosaics. However, the conservation implications of habitat heterogeneity in these mosaics, and the patterns of phylogenetic and functional diversities are virtually unknown, which hinders appropriate planning of ecological restoration programs and conservation-oriented habitat management. We compared species composition, species richness, Shannon diversity, functional and phylogenetic diversity among eight habitat types in forest–grassland mosaics of the Kiskunság Sand Ridge, Hungary. Our study revealed a compositional gradient, ranging from large forest patches through smaller-sized forest patches and edges to closed and open grasslands. Each habitat had species that were rare or absent elsewhere. North-facing forest edges and open annual grasslands had the highest species richness and Shannon diversity, respectively. Forest patches had high functional and phylogenetic diversity, underscoring their ecological and conservation importance despite the fact that they are usually overlooked in conservation practice. We found that taxonomic diversity indices were poor surrogates for functional and phylogenetic diversities. Our findings emphasize that the habitat heterogeneity of mosaic-like ecosystems needs to be taken into account in research and nature conservation practice. Furthermore, conservation should consider various aspects of diversity, including functional and phylogenetic diversity, instead of exclusive emphasis on taxonomic diversity indices.

Trophic structure and the effect of environmental variables on riverine fishes in an anthropogenically altered river ecosystem

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Although the concept of trophic interactions has been used for long time, there are still considerable gaps in our understanding of the trophic interactions of river fish communities. Stable isotope analysis can be used to infer ecological niche use in fish. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of 20 species of fish belonging to both eurytopic and rheophilic ecological groups from a large temperate river were used to evaluate trophic niche use, and to find out how environmental variability affects individual and community-wide aspects of trophic structure. Of the 11 environmental variables tested, nutrients had a significant effect on trophic niche area of species, indicating that eutrophication is of critical importance for fish communities. Isotopic niche area of species was found to be positively influenced by total phosphorus, and negatively affected by concentrations of N-NO_3^- and ammonia (N-NH_4^+). Niche diversification and total area of niche space (TA) were highest at sites with high heterogeneity of both in-river and adjacent habitat, reflecting high resource diversity in less channelised reaches. An observed pattern where nutrient loading influenced both individual species and the overall trophic structure of the fish assemblage provides strong support for an anthropogenic influence on riverine food webs.

How to single out species and populations for monitoring of genetic diversity

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One of the main challenges for conservation today is understanding changes in biodiversity. Genetic diversity provides the foundation for biodiversity and is necessary for long-term survival, adaptation, and resilience not only for individuals, but also for populations, species,

and entire ecosystems. Monitoring genetic diversity across different time points is a first step to gain insight into the extent to which populations or species might be at risk, to guide conservation action and to provide evidence for solutions. However, putting genetic diversity monitoring into practice in the form of an effective, implemented project can be challenging. To help guide practitioners through the decision and evaluation processes of identifying the most appropriate set of species or populations to monitor in a genetic diversity monitoring project, the IUCN SSC Conservation Genetics Specialist Group has produced a guidance document. A suite of steps and considerations that needs to be taken into account when planning a genetic diversity monitoring project will be presented, followed by criteria which should be evaluated to select which species and populations to monitor. Lastly, different key aspects will be highlighted, and case studies used to illustrate different approaches to establishing genetic diversity monitoring projects.

Social–ecological forest management as a strategy in the concatanant forest, biodiversity and climate crises

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The loss of functioning forest ecosystems is intimately linked to the current biodiversity crisis and increases the vulnerability of the global ecosystem in the anthropogenic climate crisis. The concept of social–ecological forest management is based on a systems ecology approach. In the face of Earth crises, the goal of best preserving ecosystem functioning includes maintaining or restoring their dynamic capacity to resiliently adapt and evolve. Social–ecological systems result from their complex and intertwined interactions and interdependencies. Social–ecological forest management is ecosystem-based and human-centered. This means that, in addition to a paradigm of ecosystem functioning that can be scientifically described and justified, appropriate ethical considerations and orientations must be taken to provide an expedient framework for management. In the face of existing challenges and lines of conflict, social–ecological forest governance must contribute to the creation of frameworks through social instruments and discourses that ensure the maintenance and promotion of forest ecosystems as well as of a contemporary forest justice, in the sense of the fair and equitable use of all ecosystem services needed for human well-being. The growing importance of regulating ecosystem services means that forest management must emancipate itself from the primacy of timber harvesting.

Haymeadows and pastures in the present and past. Traditional and historical knowledge in successful species conservation

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European biodiversity is threatened by changed land-use, and a key conservation measure is to restore degraded habitats and improve habitat management. Targets for restoration and management are, however, often difficult to identify due to lack of sites with favorable conservation status. Studies of declining populations and degraded habitats may provide misleading information about what is the suitable habitat. It is therefore necessary to trace earlier, more favorable conditions, for example by using traditional ecological knowledge (Berkés et al. 2000, Roué and Molnár 2017) and historical knowledge in combination with ecological knowledge (Westin et al. 2018).

We present results from own interdisciplinary research in which Swedish threatened hay–meadows are compared with actively used meadows in Romania in order to identify management practices of key importance for biodiversity. We discuss the effects on threatened plant and insect species of mowing and grazing regimes in meadows, as well as temporary cultivation. Our paper also includes the use of reference landscapes, i.e. learning about traditional management and species in landscapes where they are still common, for conservation where they have become rare.

Mainstreaming the importance of Riparian Zones in Norway

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The presentation will contribute with the observations, experiences and reflections from the point of view of the Environment Agency on the aspect of environmental governance for protecting and restoring Riparian Zones in Norway. The presentation will look specifically at examples and experiences concerning the roles and interplay of different actors like research institutions, authorities at different levels, and NGOs.

The Research Institutions develop the knowledge base for decision-makers, for instance the Norwegian Institute of Bioeconomy Research (NIBIO) and the Norwegian Institute of Water Research (NIVA). The Central Government (ministries and agencies) develop the national Legal Requirements and Guidelines for environmental policy, land use planning, environmental impact assessment etc. Responsibilities are divided between different authorities, creating challenges for integration of objectives and coordination of activities.

Regional authorities are key to translating the national policy into action, when they develop River Basin Management Plans, as well as advising and inspecting the local authorities (municipalities) who are the actual decisionmakers concerning land use.

There are also dedicated environmental NGOs making use of the knowledge and working in more creative ways to conscientize the public, aiming to influence policy.

Putting land-use actors in focus for improved conservation planning and effectiveness

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Estimating human-wildlife encounters is the key concept for the assessments of both the threats to biodiversity conservation. While many factors are considered to be associated with the human-wildlife encounters, it can be conceptually modeled as spatio-temporal overlaps between human and wildlife presence. In rural to frontier environment, spatial aspects of animal presence is often represented as species distribution model or abundance model, while temporal nature is rather difficult to capture. On the other hand, spatio-temporal activities of human is often captured as hunting pressures or land cover changes in conservation and ecology context. With these methods, we are deeply in need to address the issue of human agency, meaning how each human decide what to do in where at which timing. In my talk, I will introduce the modeling framework and concept of Agent-based modeling (ABM) in the human-wildlife encounter rate by using the example of Guyana's savannah and Sri Lanka's farmers. I will discuss how to model spatio-temporal nature of animals and humans, while taking human agency in the center piece of mechanism. I will also discuss potential of such methods to explore the dual objectives of human-wildlife interactions in conservation and public health.

Societal extinction of species

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The ongoing global biodiversity crisis not only involves biological extinctions, but also the loss of experience and the gradual fading of cultural knowledge and collective memory of species. We refer to this phenomenon as 'societal extinction of species' and apply it to both extinct and extant taxa. We describe the underlying concepts as well as the mechanisms and factors that affect this process, discuss its main implications, and identify mitigation measures. Societal extinction

is cognitively intractable, but it is tied to biological extinction and thus has important consequences for conservation policy and management. It affects societal perceptions of the severity of anthropogenic impacts and of true extinction rates, erodes societal support for conservation efforts, and causes the loss of cultural heritage.

Transience of public attention in conservation science

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Societal awareness of, and engagement with, environmental problems is a critical prerequisite for effective conservation programs. Research has revealed a strong general pattern whereby public attention received by cultural products diminishes over time. If transposed to conservation, this transience of societal attention is likely to be of major importance because it can limit motivation to support conservation efforts. We address the concept of conservation-attention transience, discuss its major drivers and mechanisms, and provide a short overview of conservation issues for which this phenomenon is expected to be particularly relevant. Attention transience leaves a brief window of opportunity for conservationists to focus public awareness and to mobilize necessary support. In this context, it is critical to maximize the conservation benefits generated during these short bursts of attention, especially through tailored conservation marketing campaigns with targeted message framing and regular efforts to re-focus attention on key issues.

Foraging personalities modify effects of habitat fragmentation on biodiversity

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Habitat loss poses a substantial threat to biodiversity, but whether fragmentation per se drives the loss of species is still widely debated. While negative consequences from fragmentation are often anticipated, many empirical studies report positive effects suggesting that intrinsic mechanisms governing species' persistence are not fully understood. We investigated consistent personality-dependent differences in foraging behaviour among individuals as a possible mechanism underlying the discrepancy of reported fragmentation effects. We used a mechanistic individual-based model to simulate home range behaviour of a competitive mammal community based on the availability of a shared resource. Thereby, the personality of an individual dictates its foraging decisions at risky habitat edges, an inherent property of fragmentation per se. Our simulations show that differences in risk-taking while foraging are a further mechanism contributing to the reconciliation of the fragmentation debate. While risk-averse communities displaying edge avoidance confirm the negative effects of fragmentation, risk-prone communities show a neutral response. Furthermore, fragmentation positively impacts biodiversity and species coexistence for behaviourally diverse communities including risk-averse and risk-prone individuals. Our study highlights the importance of recognizing the behavioural composition of communities for estimating fragmentation effects, because different personalities can influence the coping abilities of animal communities in light of fragmentation.

Long term tracking of big mammals in detail: how could new biologging techniques improve data for wildlife management

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Long-term tracking is one of the most important methods for studying animal behavior. Scientists are developing more sophisticated devices for tracking during the last decades, but continuously long-term tracking and detailed behavior description have not been possible yet. Here we take advantage of the emergence of biologging technologies to characterize the adaptive significance and biophysical mechanisms underlying analyses in free-roaming wild boar and red deer. We have designed biologging collars equipped with tri-axial accelerometer and magnetometer sensors and GPS tags. During the last 3 years, we tested these devices on 85 wild boar and 36 red deer. The average tracking period was 103 days (maximum 202) for wild boar and 203 days for red deer (maximum 413). Accelerometer data from a subset of individuals was synced with ground-truth video records to develop and test behavioral classifiers using machine learning techniques. Behavioral classifications were then time-synced with magnetometer and GPS for calculation of real path of the animal by dead-reckoning. A preliminary analysis based on these new technologies gives us detailed information about animals' lifestyles. Furthermore, the continued development of these technologies and techniques will offer new opportunities to investigate a range of important biological and ecological topics.

Naturalistic grazing in crowded Central Europe: from reintroduction of megafauna to rational landscape management

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Naturalistic grazing by large herbivores is an increasingly practiced way of landscape management in areas of nature conservation value. It has the potential to restore and enhance biodiversity, creating self-sustainable environments vital for organisms requiring regular disturbances to moderate and/or reverse successional changes. Despite the growing number of the large herbivore „grazing reserves” throughout Europe, science-based methodology and critical results assessments of the influence of large herbivores on different components/levels of biodiversity remain virtually non-existing. In Czech Republic alone, the natural grazing schemes grew from 15 horses on 40 ha in 2015, to >200 horses, European bison and semi-wild *Tauros* cattle on >600 ha in 2021. Based on the Czech experience, good practice in naturalistic grazing requires cohesion to the following premises: i) involvement of autochthonous herbivore taxa, ii) extensive grazing of ≤1 animals/ha, iii) cross-grazing combining equids and large bovids wherever possible, iv) year-round grazing, v) maintenance of landscape connectivity for free-living wildlife, vi) restricted access of public, vii) biological monitoring and viii) herd management in accordance with international species conservation (European bison) and breeding programs (pedigree books etc.). Although trivial on first sight, all these requirements are rarely met in the existing European grazing reserves.

Former military training area Milovice (Czechia): changes of landscape and vegetation mosaic in the regional biodiversity hotspot

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Former military training areas (MTA) are long recognized unique regions of high biodiversity and habitat variability in otherwise intensively utilized and homogenized Central European landscapes. Changes of land cover and development of forest and non-forest vegetation were analyzed by GIS methods in MTA Milovice in the

context of historical events and nature conservation. Geodatabases with classification of land cover (24 categories including 6 types of woodlands according to canopy closure and species composition, and 5 types of non-forest vegetation according to its architecture) were generated using series of aerial photographs from the period 1950–2019 covering substantial part of the military history of the area and its entire development after abandonment. Over 50 % of the area experienced changes, especially forest closure (15 %), agricultural intensification (15 %), urbanization (11 %), and afforestation (10 %). The area of temperate grassland-savanna decreased by staggering 57 %. Homogenization of grassland-savanna vegetation structure after abandonment and its renewal after introduction of conservation management was revealed. Our results provide historically the very first exact evidence of enormous losses of habitats of high conservation value and impact of different management methods in former MTAs, highlighting a need of immediate systematic conservation actions in these unique areas.

Protected areas have a mixed impact on waterbirds, but management helps

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International policy is focused on increasing the proportion of the Earth's surface protected for nature. While studies show that protected areas prevent habitat loss, there is a surprising lack of evidence for their impact on species' populations: existing studies are local scale or use simple designs that lack appropriate controls. We explore how 1506 protected areas have impacted the trajectories of 27,055 waterbird populations using a robust Before-After-Control-Intervention study design, which compares protected and unprotected populations in the years before and after protection. We show that the simpler study designs typically used to assess protected area effectiveness (before-after and control-intervention) incorrectly estimate impact for 37–50% of populations. Using our robust study design, we find that protected areas have a decidedly mixed impact on waterbirds, with a strong signal that areas managed for waterbirds or their habitat are more likely to benefit populations, and a weak signal that larger areas are more beneficial than smaller ones. Calls to conserve 30% of the Earth's surface by 2030 are gathering pace, but protection does not guarantee good biodiversity outcomes. As countries gather to agree the new Global Biodiversity Framework, targets must focus on creating and supporting protected areas that measurably benefit populations.

Birds in gilded cages: An investigation of the illegal trade of wild songbirds in the EU

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Even though wild bird imports into the EU have been banned since 2005, live birds are regularly among the most seized wildlife commodities entering the EU. However, confiscation reports have focused on parrots and birds of prey, although the EU has been implicated in the international songbird trade recently.

Here we analysed data from the Songbirds in Trade Database (SiTDB) on songbird trade in the EU. The SiTDB holds records of wild songbirds on sale from 2006–2020, relative trade volumes in the EU compared to the population size in the wild, difficulty of captive breeding and reports of EU captive breeding. We found 907 (13.8 %) wild-sourced songbird species on sale including 30 (3.3 %) threatened species and 38 (4.2 %) species protected under the EU Wildlife Trade Regulations. Most species had low relative trade volumes though 96 (10.6 %) species were reported with high or extreme trade volumes including 3 threatened species. Half of the species were traded wild despite having EU captive breeding reported.

Our results highlight a largely undocumented illegal trade in wild songbirds in the EU showing that demand for songbirds continues despite the import ban on wild birds and captive breeding within the EU.

The effects of an ecosystem engineer species (*Castor fiber*) in the light of the biodiversity crisis along Central European watercourses

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Wetlands are exposed to several threats, e.g., the loss of habitat complexity, decreasing water levels and biological invasion. Beavers, as ecosystem engineers, are able to influence these processes. We studied the selective foraging of beavers at 20 sites along the Danube and its tributaries. Additionally, 10 further beaver-altered habitats were surveyed to understand the effects of beaver dams on amphibian and reptile species richness. We counted amphibian and reptile individuals along transects and registered egg clutches and larvae of amphibians to assess the reproductive success of each species. We also involved the 5 largest beaver-reconstructed wetlands in bird monitoring surveys. Based on our results, beavers generally preferred native woody species against invasive ones, which may indirectly accelerate the process of the biological invasion. However, dam-building created habitat for several studied native vertebrate taxa: Nine amphibian species used the beaver meadows and ponds as breeding sites and migratory waterfowl used them as a stop-over site. Our study supports that, by the rapid reoccupation of aquatic habitats in their former range, beavers might become a driver of landscape change across Europe. Therefore, understanding their effects on the environment will have critical importance in conservation planning and freshwater habitat management.

European conservation and restoration options under future land-use scenarios

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The new EU Biodiversity strategy specifies that 30% of terrestrial land should be managed for conservation. However present land-use systems often prevent more stringent conservation measures, instead requiring restoration in many intensively used areas while also avoiding leakage effects by displacing land-use changes elsewhere. To estimate the impacts of proposed EU policies, such as the EU Restoration Law or the Farm-2-Fork strategy, on biodiversity, a systems perspective is necessary, that jointly considers both conservation, restoration and anthropogenic land uses. We combine conservation objectives from the EU Biodiversity Strategy with targets and constraints on land uses derived from integrated assessment models customized to European land-use and conservation policies to 2030. Using multi-criteria spatial-planning we then identify areas where conservation and restoration would bring the greatest biodiversity benefits in the future subject to the opportunities and constraints imposed by land-use changes. The results show that considerable trade-offs exist for various taxonomic groups and geographic regions, and that the right areas need to be targeted to maximize benefits. Overall, this work highlights pathways for future efforts to conserve and restore 30% of European land. It furthermore quantitatively evaluates European conservation policies with regards to their upper potential value.

The impacts of agricultural land use and production on vertebrate biodiversity differ greatly across products, space and biodiversity indicator

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It is becoming increasingly clear that achieving conservation targets will require transformative changes in the way societies operate. Part of such changes revolve around consumption patterns. Indicators depicting biodiversity implications of individual products can be a useful tool to assess the impacts of consumption choices. The multi-faceted nature of biodiversity poses a challenge to developing such indicators and communicating insights derived from them. Here we present a novel set of indicators, depicting how agricultural production – through land use and its intensity – impacts terrestrial vertebrate biodiversity. For this, we combine global data on land use, agricultural production and species distributions with a countryside species–area relationship model. We developed two spatially explicit indicators for the contribution of individual agricultural products to: (a) regional decline in species richness at the landscape level, and (b) global biodiversity decline, via accounting for the share of species ranges affected by the respective land use in a given landscape. Our results show that the different indicators yield complementing, often contrasting, insights on the biodiversity implications of agricultural products. Presenting the results for selected individual products and production areas highlights how these indicators help assessing the effect of altered consumption choices on biodiversity across different scales.

Acknowledging wild animal suffering and the need for compassion challenges conservation fundamentally

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The literatures on wild animal suffering and on compassionate conservation both strive to take the moral status of wild animals seriously. But the former is championed by philosophers; the latter by conservation scientists – and there has been to date no cross-pollination between them. While compassionate conservationists advocate for greater concern for the harms which conservation inflicts on wild animals, the literature on wild animal suffering points out that wild animals suffer all the time, even without human intervention. If real compassion means being concerned with suffering no matter how it is caused, then the surprising consequence is that compassion challenges conservation itself. While compassion will justify conservation where human activity can be said to be the greatest cause of suffering, in most cases this is in fact not so; rather, most suffering is a result of evolutionary and reproductive processes. Compassion should therefore motivate us to look for new ecological setups, and some suggestions are given. While the practical consequences of this new approach require greater investigation, what is stressed is that an ideological switch is needed, such that decisions in environmental management are justified based on their expected impacts both in terms of anthropogenic and natural suffering.

Revealing threats through the full annual cycle in a long distance migratory bird species

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The worldwide decline of the avifauna disproportionately affected migratory birds. Full annual cycle approach is necessary to understand the processes driving these changes as migratory species use different areas during the breeding and the non-breeding periods when different factors may affect the individuals. The European roller is a long-distance migratory species which entire European population has undergone a serious decline, and except from a few countries with current positive trends, it is still decreasing nowadays. Our aims were to reveal the movement patterns of rollers including the study of home-range and habitat use during breeding season and also the migration phenology, migrations routes, stopover and wintering sites. The adult rollers were tagged between 2015 and 2021 in Hungary. Our results showed high individual variability of home-range size during the breeding period. We found the Sahel region as an important stopover area, where we found the frequent use of croplands, contrary to the wintering areas which were mostly characterized by natural grassland vegetations. Our results contribute to the better understanding of the movement patterns and habitat requirements of the species during the full annual cycle enabling us to plan comprehensive, and therefore effective conservation strategies

The value of biodiversity interventions in agricultural landscapes

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The conservation of biodiversity in agricultural landscapes requires farmers to integrate biodiversity management into their farming practices. An increasing body of ecological literature suggests that this could produce a win-win situation. More species-rich ecosystems function more effectively which leads to enhanced ecosystem service delivery such as carbon sequestration, pollination, pest regulation and ultimately crop yield. Biodiversity therefore adds value to farm businesses and this represents a rational argument for biodiversity enhancement. However, few farmers are actually adopting biodiversity management. Here, we discuss some of the drivers underlying this reluctance. We show that when the costs of biodiversity management are taken into account, currently, managing for ecosystem service delivery is often not profitable. Many of the ecosystem services that are enhanced by biodiversity management represent public goods that benefit society at large but do not benefit individual farmers. The value of some of these public goods are furthermore non-rational and difficult to quantify economically. Because farmers operate in a global economy, this suggests that effective biodiversity conservation on farmland requires stronger economic incentives than are currently available to farmers.

Optimising agricultural landscapes for biodiversity conservation and crop production using yield maps and ecological theory

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Intensively-managed temperate agricultural landscapes are dominated by large arable fields and suffer from biodiversity loss and biotic homogenisation. However, environmental conditions between neighbouring fields or even within a single arable field can still differ remarkably. In our talk, we will introduce the concept of employing arable land heterogeneity, in combination with surrounding landscape structure, as key information for landscape optimization. We propose a conceptual framework that uses yield maps (a tool commonly employed in precision agriculture) to identify low-yield zones within arable fields and ecological theory to select the best areas for setting aside from crop production. As a result, optimized landscapes will keep high production potential (crop yield) and improve biodiversity support at the same time. Strengths of the proposed concept, potential shortcomings (e.g., data availability) as well as existing knowledge gaps and future research challenges will be discussed.

Socio-psychological factors, beyond knowledge, predict people's engagement in pollinator conservation and reveal new opportunities for increasing uptake

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Human behaviour is critical to conservation. However, despite numerous government strategies and extensive ecological research on pollinators, the drivers of people's engagement in pollinator conservation remain overlooked. We used a large-scale, online questionnaire (1,275 responses) to address this gap, framed around the Theory of Planned Behaviour. Perceived behavioural control (feeling able to help pollinators) and nature-connectedness (a stronger connection to nature) were consistently important predictors of people's pollinator conservation actions, whilst the importance of other socio-psychological factors depended on the particular conservation action. From a practical perspective, our findings suggest 1. Several simple, low-cost pollinator conservation actions are currently under-utilised and should be priorities for pollinator conservation programmes. 2.

Strategies are needed to overcome reported practical barriers, such as communicating simple beneficial actions that can be carried out with limited time, space and money. 3. Knowledge is just one (relatively less important) factor that predicts pollinator conservation behaviour. Finally, we believe that engaging, inspiring, and empowering the public to help pollinators and take responsibility for their local environment will increase pollinator conservation. These findings are also relevant to other conservation challenges where public action could strongly impact.

High-flying insect abundances in urban versus rural systems

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Insects are of increasing conservation concern as their abundance and diversity has recently been reported to decline. Most of what we know on their decline is derived from studies on insects close to the ground. Generally, we do not know much about high-flying insects, and accordingly also not much about factors driving their abundance. Here, we thus tested whether the abundance of high-flying insects differs between rural, urban and mountainous landscapes, whether their abundance is related to meteorological factors or the hour of the day. The abundance of high-flying insects was recorded using vertical-looking radar devices. Despite colder temperatures in mountainous regions and a clear positive relationship between high-flying insect abundance and temperature, we found the highest abundances in the mountainous regions. In contrast, in the lowlands, abundances did not differ between urban and rural landscapes. We conclude that land-use on the ground affects the abundance of high-flying insects, and that rural areas in the lowlands offer similarly poor conditions for high-flying insects as do urbanized areas. Conservation measures should therefore also account for the needs of high-flying insects.

Safeguarding biodiversity by modifying law

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Biodiversity loss continues although the Convention on Biological Diversity (CBD) has been in force almost 30 years with three main objectives: 1. the conservation of biological diversity, 2. The sustainable use of the components of biological diversity and 3. The fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Regardless new 20 Aichi Biodiversity sub-targets ecological information gives more alarming signals about the poor state of global biodiversity. Conservation biological and ecophilosophical studies have shown that biodiversity needs protection as a complex dynamic system and a target of diverse values. However, the legal implementation of the biodiversity objectives is not successful. At least two aspects can explain the reason. Firstly, the CBD has originally too narrow objectives to safeguard biodiversity. Policy instruments for biodiversity conservation and for the sustainable use of its parts will not guarantee the safeguarding if biodiversity degrades because of pollution or climate change. Secondly, the safeguarding objective cannot be achieved by means of traditional legal solutions and relationships. Recognizing legally relevant safeguarding relationships between persons and nature can improve with new policy instruments the implementation of biodiversity targets. The presentation gives some examples for the legal development towards biodiversity law.

Megaherbivores rewilding and functional diversity of affected communities: Plants and insects across refaunated sites in Czechia

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Rewilding incomplete ecosystems by native megaherbivores is increasingly viewed not only as a tool for efficient vegetation management, but also as a way to restore functional richness and interactions in biota of refaunated sites. A dozen of medium-size localities, from wetlands to dry grasslands, had been refaunated by combinations

of horse, aurochs and wisent in the Czech Republic. We use data obtained from monitoring refaunation effects on vascular plants, aculeate Hymenoptera, butterflies and Orthoptera to test the hypothesis that refaunated sites should display higher plants and insect species and functional richness than controls. Within each group, we also disclose specific sets of life history traits associated with megaherbivores presence, and discuss the mechanisms of megaherbivores effects. We conclude that much of the nature management practices conventionally associated with traditional land uses, and carried out by reserve managers in small scales, are in fact mimicking impacts of native megafauna, historically extirpated, and now hopefully returning, to European ecosystems.

Effects of urbanization on biological control of insect pests and associated functional groups: a global meta-analysis

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Biological control is a major ecosystem service provided by natural enemies, especially in densely populated areas where chemical plant protection poses severe risks to human and environmental health. However, the impact of urbanization on this service and the abundance patterns of relevant functional groups (herbivores, predators, and parasitoids) remains contested. By performing three hierarchical meta-analyses on 51 relevant studies, we showed that advancing urbanization leads to outbreaks of sap-feeding insects, declining numbers of predators with low dispersal abilities, and weakened overall biological pest control delivered by arthropods. In addition, we found a strong contrast between species- and community-level observations for both herbivore and natural enemy abundances with a significant positive effect of urbanization on herbivore species and a marginally significant negative effect on natural enemy communities. Our results suggest that sedentary predators may have the potential to effectively regulate sap-feeders, one of the most important pests in urban environments. A well-connected network of structurally diverse and rich green spaces with less intensive management practices is needed to promote natural plant protection in urban landscapes and sustainable cities.

Sown set-aside fields promote biodiversity at local and landscape scales in Hungary

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In the last two decades, Hungarian agricultural landscapes have faced new challenges and opportunities since the EU accession. While certain intensification processes endanger the comparably high biodiversity, agri-environment schemes (AES) are devoted to halting species loss and maintaining ecosystem services. Besides the horizontally available AES, special schemes are available regionally for e.g., protection of great bustard, red-footed falcon, or farmland birds in general. Some of these regional schemes require the withdrawal of a certain percent of arable fields from production for 1–3 years, turning them to sown set-aside fields, mown once per year. We conducted studies on the suitability of such set-aside fields for wild plants, different arthropod groups, farmland birds and showed their general benefits for grasshoppers and butterflies and increasing positive effects by set-aside age for wild plants and farmland birds. We also tested the landscape-scale effects of set-asides on wild bees, hoverflies, and predatory wasps and found that reproductive success of cavity-nesting bees and wasps was positively related to the presence of set-aside fields in the landscape and increased with their proportion. We conclude that set-aside fields in a mosaic agriculture landscape can be highly beneficial for biodiversity and are worth maintaining in future AES.

Identity of grazing livestock and intensity jointly shape grazing effects on sand grassland vegetation

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Conservation of biodiversity in agriculture-driven landscapes have a crucial importance; their conservation and restoration have a top priority both in research and practice. We compared the effects of cattle and sheep grazing on sand grassland vegetation under various grazing intensities. The composition of the vegetation was surveyed in 2 by 2 m plots, and biomass was harvested in from an area of 20 by 20 cm. We found that both the identity of livestock and grazing intensity significantly affected the vegetation composition and most of the biomass fractions. With increasing grazing intensity, the amount of litter and graminoids decreased with typically lower values in sheep grazed sites. The amount of lichen and moss biomass were decreased with increasing grazing intensity and the highest values were mainly detected in exclosures. The total biomass was the lowest in sites grazed by sheep in high intensity. With increasing grazing intensity, the cover and biomass of short-lived species increased. Our results suggest that in conservation and sustainable management of sand grasslands not only the grazing intensity, but the identity of livestock should be carefully selected and adjusted.

Natura 2000 and forest conservation

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The most valuable European forests are organized within Natura 2000, a unique EU-wide network of protected areas, which aims to maintain European biodiversity. In time of climate change and the increasing frequency and intensity of natural disturbances, forest managers, conservationists, police makers together with involved NGOs and citizens are discussing and negotiating the most appropriate management for the Natura 2000 forests. Nevertheless, improvement of forest management is long-lasting and politically sensitive processes because of the multifunctional role of forests, private ownership (only 40 % of EU forests are state owned) and ingrained habits of traditional forestry. One would expect that at least in protected areas, where old growth and natural forests are protected, the situation is better. However, there are numerous examples showing that even there, site managers, state authorities and politicians are not always ready to consider the unforeseen events related to climate change. Scientific recommendations are insufficiently accepted in practice and managerial decision-making is often based on personal knowledge, previous experience, or political influence. Clear management guidelines at European and national levels are lacking in many protected areas. Key procedures needed to improve the situation are going to be proposed during the ECCB2022 Symposium.

Animal migration to the North breeding grounds: still advantageous strategy or maladaptive behaviour?

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Every year, many wild animals undertake long-distance migration to breed in the North, taking advantage of seasonally high pulses in food supply, fewer parasites and lower predation pressure in comparison with equatorial latitudes. However, growing evidence suggests that climate change-induced phenological mismatches have reduced food availability. Furthermore, novel pathogens and parasites are spreading Northwards, and nest or offspring predation has increased at many Arctic and North temperate locations. Altered trophic interactions have decreased the reproductive success and survival of

migratory animals. Reduced advantages for long-distance migration have potentially serious consequences for community structure and ecosystem function. Changes in the benefits of migration need to be integrated into projections of population and ecosystem dynamics and targeted by innovative conservation actions. We will discuss recent disruptions of migration profitability for birds, mammals and insects, together with consequences for population dynamics, community structure and ecosystem functioning as well as effective conservation measures.

Digital and traditional marketing approaches for effective fundraising in conservation

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Financial shortages hamper biodiversity conservation. Fundraising using digital marketing measures can help address financial shortages in conservation. However, there is little evidence concerning the efficiency of digital efforts compared with the traditional approaches. We conducted real-world field experiments using Facebook and mailshot advertisements to understand how digital and traditional conservation fundraising approaches perform. Specifically, both experiments compared three types of message frames: Simple, Seed money, and Ecological.

The current study found that advertising costs on Facebook exceeded the donation amounts, although the opposite was true for the traditional approach. Also, the message framing focused on Seed money, which emphasizes the amount already donated, outperformed the ecological framing focused on threatened species. These findings demonstrate that fundraising using digital marketing has unique challenges, and traditional strategies cannot be simply replaced with digital measures. Further collaboration of practitioners and researchers will provide rigorous behavioural evidence to develop effective and efficient fundraising in conservation.

Responses of large carnivores and their prey to landscape heterogeneity in Polesia(Ukraine): before the war started

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Large carnivores are the first species to be lost from fragmented landscapes, which in turn causes disruption of food chains from the top down and thus causing cascading effects. Wolf, lynx, and brown bear were once widely distributed throughout the Palearctic and Nearctic biogeographical areas, yet their former ranges reduced drastically during the last centuries. Studies on large carnivores are heavily biased toward developed countries or countries with charismatic and endangered species. One of the "blind spots" is Polesia region (Ukraine, Belarus) where there is substantial uncertainty about large carnivore distributions, densities and how different landscape features may affect their habitat use, movements, and dispersal. Parts of Polesia were under formal protection yet the protected system did not ensure adequate protection. Since July 2020, camera traps were systematically applied for large mammals' monitoring in the Ukrainian part of Polesia (181 locations) and for lynx monitoring in Chernobyl Exclusion Zone (67 locations, 2020–2021). Collected data enabled to map regional distribution for large mammals and revealed the impact of environmental and anthropogenic factors on the occurrence on large terrestrial mammals in areas with different levels of protection (exclusion zone, reserves, national parks, and expansion zones).

Land systems for mapping and understanding interactions among threats to biodiversity

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Interactions among different threats to biodiversity, such as habitat transformation and hunting, are a key reason for the global erosion of biodiversity, but these interactions remain weakly understood. A key reason for this is insufficient data on the spatial prevalence and dynamics of different threats. We here highlight the potential of mapping social-ecological systems for a deeper understanding of the geography of threats. We showcase this approach for the entire South American Gran Chaco (1.1 million km²), a global hotspot of deforestation and defaunation. Specifically, we built a typology of so-called 'land systems', representing distinct combinations of land-use extent, practices and actors. We then used a systematic literature review to link these land systems to portfolios of threats typical for each system and developed spatial indicators to map these system back to 1985. Together, these analyses uncover where synergistic threats occur and how the spatial footprints of threats vary over time, identifying intensifying or relaxing interactions. For conservation planning, this provides a pathway towards spatially targeting threat-specific interventions, to more directly address synergistic threats, and to identify the key actor groups associated with them.

Data uncertainties in spatial conservation plans: which ones are important?

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Spatial prioritisation methods, which identify priority areas for targeting conservation actions, are frequently used to guide conservation programs and land use decision-making. Uncertainties in input data and how these affect conservation solutions, have long been of central interest to both conservation scientists and practitioners. Because conservation priority maps are underpinned by biodiversity data, the greatest effort has traditionally focused on perfecting their accuracy. What is perhaps less well understood is that in spatial resource-allocation problems, some data influence the final solution far more strongly than others, and resolving uncertainty in the highly influential data layers is thus most important for the stability of the priority solution.

Using examples from different conservation case studies, I show that uncertainties in conservation costs, threats or vegetation condition often outweigh the impact of individual biodiversity data on conservation plans. In addition, I show that the decisions we make on which data to include and how we modify them before their use may have larger impacts on the prioritisation result than uncertainties in any individual species data. Understanding how different data types and their use affects spatial priorities is useful as it helps to focus our efforts in data improvement to those uncertainties that matter.

A novel digital approach to quantifying political vulnerability of protected areas

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Protected areas (PAs) are often seen as opportunity costs and are therefore vulnerable to political decisions. PAs with high levels of public support should be more resilient to such decisions because: i) politicians in democratic societies are reluctant to make unpopular/controversial decisions that go against public opinion, and; ii) the proposed development of popular PAs is more likely to be met by vigorous public resistance. Nevertheless, public interest and, by extension, support for protected areas has rarely been considered in PA risk assessments. We propose an innovative approach to assessing the political vulnerability of PAs that combines indices of developmental pressures with an innovative culturomic-derived metric of

public interest based on Wikipedia page views. We use this to quantify the political vulnerability status of 523 Brazilian PAs. Large number of PAs are identified as politically vulnerable, having a combination of high developmental pressure and low/very low levels of public interest. Such PAs should take measures to increase public interest to ensure a healthy base of public support in the future. More generally, digital metrics of public interest are simply and inexpensively generated, and could be easily incorporated into the existing assessment systems.

Science–management initiatives to monitor genetic diversity using newly proposed indicators

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Monitoring of genetic diversity to understand rates of change and identify potential threats to this vital part of biodiversity is becoming increasingly put into practice. Indicators for this level of diversity have recently been put forward both for international use within the context of the post-2020 Global Biodiversity Framework of the Convention on Biological Diversity (CBD) as well as at national levels. These indicators are now being tested in several countries and an update of such efforts and their outcome will be provided in this presentation. One of the countries involved in this work is Sweden where long-term science–management collaborations have resulted in monitoring of genetic diversity now being increasingly included into national monitoring efforts, particularly in aquatic environments. Newly proposed indicators using genetic data are being applied to pilot species including several fishes and habitat forming species. Results from these ongoing efforts will be presented and discussed.

Optimizing Agricultural Landscapes for Biodiversity and Ecosystem Services.

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Sustainable and resilient agricultural systems are needed to feed and fuel a growing human population. However, the current model of agricultural intensification which produces high yields has also resulted in a loss of biodiversity, ecological function, and critical ecosystem services. Along with intensification, landscape simplification exacerbates biodiversity losses which leads to reductions in ecosystem services on which agriculture depends. In recent decades, considerable research has focused on mitigating these negative impacts, primarily via management of habitats to promote biodiversity and enhance services at the local scale. While it is well known that local and landscape factors interact, modifying overall landscape structure is seldom considered due to logistical constraints. I propose that the loss of ecosystem services due to landscape simplification can only be addressed by a concerted effort to fundamentally redesign agricultural landscapes. Designing agricultural landscapes will require that scientists work with stakeholders to determine the mix of desired ecosystem services, evaluate current landscape structure, and implement targeted modifications to achieve desired goals.

Biogeomorphology and riparian ecosystem conservation

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Biota has long been shown to influence surface processes, but it has not been since recently that geoscience has taken a serious interest in understanding abiotic–biotic feedbacks. This is subject to the relatively new field of biogeomorphology, which has been expanding as a discipline, due to increased recognition of the often overlooked role that biology can play in geomorphic processes, as well as due to our increasing capacity to measure and quantify feedback between biological and geomorphological systems. Despite the recent advances, biogeomorphology has rarely been recognised in studies focusing on conservation and biodiversity. Here, I present results from a global

data collection on the ecosystem effects of beavers (*Castor fiber*, *Castor canadensis*), demonstrating the usefulness of biogeomorphology in the conservation of riparian ecosystems. Beavers are one of the most influential mammalian ecosystem engineer, heavily modifying river corridor hydrology, geomorphology, nutrient cycling, and ecosystems mainly through the construction of dams, which impounds and diverts water flow, from which most other ecosystem feedbacks follow.

Learning collaboration in the adaptive co-management environment: example from Lahemaa National Park in Estonia

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Adaptive co-management (ACM) is an approach to govern complex social–ecological systems, utilising participatory decision-making, social learning, sustainable resource use and development of adaptive capacity for social–ecological resilience. It has been applied in multiple resource management contexts across the world, incl. conservation management. However, it is still not known how collaboration can be learned in the ACM setting and how the learning process should be facilitated. This study is set in the post-communist national park with recent turbulent past and bases on a project that was carried out in Lahemaa in Estonia between 2019–2021 that created a community innovation lab, attended by 80 local stakeholders. The methodology of Lahemaa case study included qualitative methods of seven semi-structured interviews and two focus groups. In conclusion, collaborative learning occurs in the problem and interest communication through different governance levels and makes stakeholders to understand the elements of individual and collective gain. It helps them to choose collaboration partners, the structure, limitations and boundaries in which they can operate and position themselves in the local social, managerial and entrepreneurial context. Fostering collaborative learning needs outside facilitation and takes time to adapt in public sector much more than in private sector.

Does protected area establishment result in pre-emptive forest clearing? Exploring the case of Madagascar's protected area system expansion

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Slowing tropical deforestation is a major global policy objective given its role in tackling the combined challenges of climate change and biodiversity loss. Establishment of protected areas (PAs) is a commonly used tool. However, PA establishment might potentially result in unintended consequences; specifically pre-emptive forest clearing as people anticipate the upcoming policy restrictions, which has been anecdotally identified in other policy contexts. This is the first study to systematically investigate the phenomenon, and to explore whether it undermines benefits from PA establishment. We focus on Madagascar, which expanded its PA network by more than 400% between 2003 and 2017, using the synthetic control method to assess deforestation outcomes in some 300 administrative units overlapping with 25 PAs established as part of this expansion. Results suggest that pre-emptive forest clearing did occur in a large number of units. In most units, PA appears to have brought net gains in avoided deforestation, but worryingly, in many other units, pre-emptive forest clearing completely negated the intervention's gains. These findings raise concerns about the prevalence of this phenomenon in Madagascar, and potentially elsewhere, and highlight the need to revisit the assumptions underpinning the theories of change informing area-based forest conservation interventions.

Understanding the resilience of artificially drained forest–wetland landscapes

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Forest and wetland landscapes have been long transformed into semi-natural ecosystems for economic purposes such as timber production. Hydrological reconstruction into dense linear ditch networks has been a fundamental intervention behind such transformations, but its long-term perspectives for biodiversity conservation and landscape functioning are poorly understood. I introduce a basic framework and an ongoing research project in Estonia, which are focused on the key elements for such perspectives: positive vs negative feedback mechanisms of the drainage, irreversible ecological changes vs resilience in the terrestrial realm, socio-economic lock-ins, and their indicators. One can identify major disciplinary gaps of knowledge between freshwater and terrestrial ecology that have inhibited landscape perspectives to hydrological transformations. Our main field design to address some of those gaps comprises 23 forested catchments (up to 10 km² in size) that represent different combinations along artificial drainage and logging intensity gradients. This is complemented with specific systems addressing reversibility (ecological restoration) and alternative stable states (long-term trends). The ultimate challenge is to link ecological and hydrological spatial models with land-use scenario analyses.

The role of cemeteries in biodiversity conservation

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In the face of worldwide habitat loss, the role of human-shaped habitats in conserving biodiversity is becoming increasingly important. Due to their special cultural role, cemeteries can preserve parts of the native vegetation when the surrounding landscape becomes degraded. However, these special refuges are threatened by human encroachment and changing management practices. Our aim was to understand the conservation value of cemeteries, mainly indicated by orchids as flagship species for biodiversity conservation. More than 2500 cemeteries were visited between 2014 and 2018 in Turkey, Azerbaijan and 12 European countries. We analysed species richness, abundance and the presence of orchid taxa in the visited cemeteries, while we also collected sporadic data of other valuable organisms, mainly other threatened plant species occurring in cemeteries. We found orchids in smaller or higher numbers, but in all visited countries. Conservation value was generally the highest in rural cemeteries, while cemeteries represent important habitats for many organisms. Our results indicate that urbanization and modern changes in human activity have a strong impact on the conservation value of cemeteries in both Europe and Asia Minor. Practices maintaining traditional burial habits and environment-friendly management of cemeteries deserve more moral and financial support.

Fostering protected area effectiveness through a social–ecological perspective

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To counteract the global biodiversity loss, the designation and extension of protected areas (PAs) is a core conservation strategy. However, their effectiveness is challenged for a variety of social and ecological reasons. Despite their stark increase in amounts and coverages over the past decades, the goal to safeguard biodiversity seems to be at the brink, as many PAs face continuing wildlife losses and land cover changes. At the same time, PAs have been accused of disrupting human–nature relationships, violating human rights, and putting a massive burden on riparian communities. At the same time, protected areas are also expected to contribute to human well-being, including those living in their surroundings. Within this paradox situation, the increasing recognition of PAs as social–ecological systems offers an opportunity to unravel interactions between people, governance, land-use changes, and biodiversity loss. Backed up by systematic lit-

erature searches, this presentation will exemplify social–ecological interactions and their potential influence on PA effectiveness referring to three empirical case studies from Romania, Tanzania, and Zambia. The approach behind elucidating these place-based insights may guide further explorations of PA effectiveness through a social–ecological perspective and help to identify the leverage potential of key interactions for integrative conservation and development planning.

Lessons to leverage policy coherence for forest multifunctionality and biodiversity

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Ambitious and transformative policy goals to address both direct and indirect causes of biodiversity loss have been set in the EU Green Deal and EU Biodiversity Strategy for 2030. These goals are entering a fragmented and misaligned landscape of existing strategies embedded in diverse and contradictory interests, especially visible in the contexts of European forests. We utilize and develop a semi-quantitative policy coherence evaluation methodology for analyzing the policy (in) coherence both vertically (across governance levels) and horizontally (between policy sectors) (e.g., Nilsson et al., 2012). More specifically, we analyze how biodiversity, bioeconomy, and forest strategies on the EU scale and in four national contexts (Finland, Germany, Norway, and Sweden) set targets for multiple forest ecosystem services (FES). Our findings explicate national differences in addressing the FES. Further, climate change mitigation is identified as a policy area, where most conflicting goals as well as greatest potential to increase coherence. Finally, the pressure to align the fragmented goals is pushed down to policy implementation on land-use level, where new information and coordination tools are needed. Our conclusions point towards approaching policy coherence as a process rather than end-goal, which would enable bundling e.g., the more ambitious biodiversity goals into ongoing policy processes.

Strengthening Ecological Monitoring Through Conservation Technology: Applying the Spatial Monitoring and Reporting Tool (SMART), Wildlife Insights and KoBotoolbox to Ecological Surveys

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Conservation technology is helping to improve the efficiency of ecological studies, empower conservation practitioners, and improve social science for conservation. Here we give an overview of three widely applied tools in monitoring and evaluation; SMART Survey, Wildlife Insights, and KoBotoolbox. SMART Survey is a component of the SMART system that allows practitioners to design and plan ecological surveys, digitally collect data on mobile devices, and incorporate these data into the central platform. Wildlife Insights (WI) is a tool for managing camera-trap survey data. KoBotoolbox is a digital data collection tool for research with people. We present an overview of the features of each tool and how they are able to support the validation, management, visualization, analysis, and sharing of ecological and social data. We provide examples of how these technologies developed by global collaborative partnerships are being applied in wildlife strongholds around the world.

Biodiversity change in terrestrial and aquatic ecosystems

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The world is experiencing a biodiversity crisis with ecosystems under escalating threat as a consequence of anthropogenic pressures on the environment. It is clear that biodiversity is imperilled, but the nature of ongoing biodiversity change is complex, and not well understood. In this talk I will summarise recent advances in documenting temporal and spatial change in biodiversity in terrestrial and aquatic ecosystems. This work shows that these patterns are complex. For

example, compositional re-arrangements (change in temporal beta diversity) are widespread. The ecological processes that underpin these changes, and the similarities and differences in how they play out in aquatic and terrestrial systems, are not well understood. I will finish by identifying a number of research challenges including how we can use new approaches to quantifying biodiversity change to deliver fundamental insights into the regulation of ecological communities, and inform strategies to mitigate damage and protect the resilience of these ecosystems.

Indigenous Knowledge Systems and Practices (IKSP) of riverine fishers in the Philippines: linking social capital to socio-ecological resilience

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We explored how traditional ecological knowledge (TEK) as a subset of social capital fosters local socio-ecological resilience to climate change (CC) and enhances biodiversity conservation efforts in the Philippines. We adopted a mixed-method purposive sampling of the 126 fishing households living within the Nabaoy River Watershed located in Aklan province, Central Philippines, and assessed their TEK with relevance to riverine biodiversity conservation and CC awareness and knowledge. The high level of CC awareness (98%) on-site is associated with extreme warming and erratic weather patterns, which are attributed to anthropogenic causes by 62% of the respondents. The most significant perceived impact of CC is the diminishing fish harvest from the Nabaoy river. TEK on-site reflects an extensive understanding of local environmental changes and resource fluctuations, reflecting the intimate relationship of subsistence communities with their immediate environments. The social taboos subscribed to by the local fishers in the Nabaoy River are largely based on the mythical spirits that are pervasive in indigenous cultures worldwide. These TEK, including social taboos, are crucial components of the local social capital and can reinforce biodiversity conservation in the Philippines and elsewhere, particularly in data-depauperate areas and in situations where formal management interventions are lacking.

Ecological rehabilitation of riparian vegetation in regulated rivers: catchment-wide environmental flows or local erosion protection?

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Riparian vegetation occupies the transition zone between aquatic and terrestrial ecosystems along rivers, and perform multiple important ecosystem services. In regulated river systems of northern Sweden, riparian vegetation has been reduced to a fraction of its former area, with concomitant losses in species richness, as a result of changes in the magnitude, frequency and timing of water-level variation. Based on the hydrologic niche requirements of riparian plants, we projected the consequences of introducing environmental flows to rehabilitate riparian vegetation abundance by (1) re-introducing more natural water-level variation in run-of-river impoundments, and (2) re-introducing spring flood events. We contrast these projections with assessments of the effectiveness of rehabilitating riparian vegetation by placing boulders in near-shore areas to reduce erosion caused by hydropowering. We conclude that while environmental flows have the potential increasing the area of riparian vegetation in entire catchments, it comes with costs associated with reductions in hydropower production. Reducing erosion by placing boulders to protect riparian zones is an effective nature-based solution but has more limited scope in terms of the potential areas being restored.

Species-habitat networks: A promising tool in applied landscape ecology

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Interventions to support ecosystem services across agricultural landscapes often require the introduction of novel habitats (e.g. hedge-rows, flower strips) across an existing mosaic of different habitats. Hence, understanding how species use resources across landscapes is essential for the design of effective management strategies. Despite recent advances in theoretical network ecology, there is still a gap between theory and applied ecological science. We propose adapting existing bipartite network tools to create species-habitat networks that explicitly evaluate the associations between species and habitat resources. This approach can describe not only single habitat and species roles across the landscape, but also emerging properties of whole habitat networks. The versatility, visualization tools, and easy interpretation of species-habitat networks enable its application to a wide range of applied conservation issues. Here, we exemplify the application of this framework by sampling pollinator and natural enemy communities in all major habitat types occurring across multiple agricultural landscapes and use species-habitat networks to determine how habitat specialization changed along gradients in landscape structure.

Pollinators and people: socio-economic drivers of allotment garden management and impacts on urban pollinator communities

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Habitat loss, including increasing urbanization, is a key driver of pollinating insect decline. Allotment gardens offer multiple socio-economic benefits, including food production, and can also improve the heterogeneity of urban landscapes acting as pollinator hotspots through the provision of floral resources. Allotment management is potentially driven by socio-economic factors which could influence ecological features and therefore pollinator community structure. I use an interdisciplinary research design to assess the role of socio-economic drivers in structuring insect pollinator communities in allotment gardens in Tyneside (UK). I sampled along a deprivation gradient to address the following questions: (1) Does the "luxury effect" – positing that neighbourhoods with higher SES (socioeconomic status) have higher biodiversity than neighbourhoods with lower SES – hold for pollinators in allotment gardens? (2) How do socio-economic factors affect allotment management and the provision of floral resources? (3) How do gardeners' perceptions of pollinators change across socio-economic groups?

Plant-pollinator interactions and floral resources were sampled in allotment sites. I used social surveys to collect information about garden management, socio-demographic features and biodiversity perception.

I present my preliminary findings and discuss the evidence for the luxury effect, to assess how to improve garden management to benefit pollinator communities in urban landscapes.

The contribution of the EU Habitats Directive to the net gain approaches of the UN Post 2020 Biodiversity Framework and EU Biodiversity Strategy

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Biodiversity is continuing to decrease widely and manifold echoed calls for reversing this trend need support from more effectively formulated and implemented rules-of-law. The UN Post 2020 Biodiversity Framework to be concluded in May 2022 contains in the past and current drafts an overall vision for global net improvements till 2050 and already some goals and targets for concrete net gains. The overall goal of this contribution is to show how the EU Habitats Directive already in its current version contributes and can further contribute

to such biodiversity net gains, besides the actions outlined in the 2020 EU Biodiversity Strategy also referring to the Net Gain Principle. Hermeneutic methods are applied such as comparative legal analyses and different types of text interpretation (e.g. historic, wording, rational). The findings identify three major parts of the EU–Habitats Directives where the implementation of the objective to achieve net gains can be legally based upon, namely the maintenance, the restoration and the compensation. The results show the already current potential of the Habitats Directive to contribute through an implementation of EU's Net Gain Principle to the overall global vision toward net improvements of the UN Post 2020 Biodiversity Framework.

Where to bee? Different types of semi-natural habitats are required to sustain diverse wild bee communities in agricultural landscapes

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Semi-natural habitats (SNHs) provide important resources for wild bees in agricultural landscapes. As floral resources fluctuate in space and time, different SNH types within landscapes could have different effects supporting diverse bee meta-communities throughout the season. Such knowledge is of critical importance for pollinator conservation. Here, we integrate analyses of alpha- and beta-diversity, as well as species-habitat networks, to examine the relative contribution of major SNH types (extensively managed meadows, conventionally managed meadows, flower strips, hedgerows and forest edges) to wild bee meta-communities in agricultural landscapes in different seasonal periods. Results highlight the importance of extensively managed meadows supporting more rare species, habitat specialists and overall bee diversity during the entire season; yet, flower strips were similarly important in late summer. Nevertheless, each of the five investigated SNH harboured relatively unique sets of bee species, with different habitats generally acting as distinct modules in the bee-habitat network. Local floral richness explained alpha- and beta-diversity within and across habitats, while landscape composition and configuration also interactively influenced species turnover between habitats. Our findings underpin the critical importance of maintaining different types of SNH offering complementary resources throughout the season to sustain diverse meta-communities of bee pollinators in agricultural landscapes.

Higher synergies and alleviated trade-offs between ecosystem services from forest policies embedding more natural climate solutions in the production landscape

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To stabilize global warming under 2 °C by 2100, societies act to increase the global terrestrial carbon sink in forests with bioenergy, bioeconomy and natural climate solutions (NCS). NCS means protection via set-aside to store carbon in standing biomass and soil. Bioenergy and bioeconomy solutions mean managing forests intensively to produce biofuels and bioproducts. NCS provide more habitat for biodiversity and non-wood ecosystem services (ES) compared to bioenergy and bioeconomy. We evaluate the future impact of policies with increasing wood demand on seven ES linked with biomass production, climate change mitigation and biodiversity in the Swedish forests under increasing climate change. We demonstrate that: (1) increasing wood demand will decrease ES multifunctionality of managed forests, but climate change will counterbalance this negative

trend; (2) climate change will negatively impact the supply of ES more strongly in production than in NCS forests; (3) increasing wood harvesting and climate change will decrease ES synergies and increase ES trade-offs, but NCS will strongly increase ES synergies and turn ES trade-offs into synergies. To conclude, even though policies of increasing wood demand will drastically reduce forest ES multifunctionality, NCS will minimize this negative impact, representing a stronghold to increase the resilience of the working landscape.

Trade-offs between timber revenues and biodiversity conservation shift for taxa differently affected by forestry in boreal landscapes

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Timber harvesting is in conflict with the conservation of several forest taxa. However, not all taxa respond equally to forestry. Forest habitat remains suitable for generalist taxa with wide ecological requirements even after management has induced sensible changes in forest composition and structure, while it decreases dramatically for specialists with narrow ecological requirements as forestry intensifies. We review the impacts of applying forest management regimes of different intensity on the trade-offs between the production of timber and habitat for boreal species with diverse ecological requirements. We show that increasing habitat for specialist taxa depending only on deadwood tends to be more expensive in terms of missed timber revenues than increasing habitat for generalists. This is because management regimes generating the highest timber revenues subtract resources from living tree biomass, which prevents deadwood production. To reduce the loss of biodiversity in the production landscape, the conservation of taxa with different responses to management should be ensured by a diversification of management regimes. In the boreal production forest, set-aside is the management regime improving more species habitat but generating no timber revenues; set-aside can be complemented by other biodiversity-friendly regimes fewer impacting revenues, and whose capacity to improve habitat is taxon dependent.

Effects of highway pollution on plant-insect interactions

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Vehicle pollution is a pervasive aspect of anthropogenic change in both urban and rural habitats. Plant-insect herbivore interactions are highly contingent on environmental variables associated with pollution, including the availability of carbon and nitrogen in leaves. Nitrogen- and carbon-based compounds are emitted from tailpipes, but the extent to which these compounds are then taken up by plants is poorly understood, as are any downstream effects on insects that feed on plants in polluted environments. Here, we demonstrate that herbivory on commonly planted oak trees (*Quercus lobata*) across the state of California is substantially elevated on trees planted within 200 meters of highways compared urban trees further from highways and rural trees. In the laboratory, caterpillars preferred leaves from highway adjacent trees and performed better on leaves from highway adjacent environments. Together, our data suggest that pollution associated with highways affects interaction strengths and may explain highly variable patterns of insect feeding within cities. While planting trees near highways may provide benefits to residents, tradeoffs between these benefits, tree health, and insect conservation should be considered in tree planting programs as the climate warms and trees are exposed to multiple increasing stressors.

Making sense of effective population size estimates in conservation

MERGEAY J

The effective size (N_e) is an important property of populations in evolutionary biology, population genetics and biological conservation. It represents how fast populations lose genetic diversity, and thereby provides information on expected future levels of inbreeding and evolutionary potential. N_e has been proposed as a key variable for evaluating the conservation status of populations and species, but the correct implementation requires conservation geneticists to calculate reliable and robust estimates. There are many ways to get N_e -estimates and each method makes various assumptions on the past evolutionary trajectory of populations, connectivity and population structure. This has led to a Babylonian speech confusion among conservation geneticists on what N_e actually represents. This makes the concept even harder to grasp for non-specialists and leads to a loss of trust in N_e as a useful variable for policy and management. Here I try to navigate the quagmire of N_e -estimation methods, discuss the critical role of knowing and checking model assumptions and illustrate this with practical examples from conservation genetics projects.

Reconnecting lynx populations across continental Europe

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The Eurasian lynx *Lynx lynx* is a wide-ranging carnivore that, following extirpation in much of Europe, is progressively recovering throughout the continent. Reintroduction and restocking of populations have been key for this recovery process. However, the species is still threatened by habitat fragmentation and genetic depletion. Hence, to better facilitate successful recolonization and to meaningfully advise policy makers on land use planning, identifying areas that ease movement of lynx are needed, yet lacking. Here, we used an extensive data set of lynx movement from 221 individuals in 11 countries across Europe to examine their resource use. We calculated landscape resistance for lynx that were categorized as either resident or disperser, and subsequently estimated functional connectivity for the two groups using circuit theory. Although corridors identified differed between the two groups, we were able to identify areas important for restoring connectivity between core populations of lynx in Europe.

User and policy needs for biodiversity monitoring in Europe

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What do users and policymakers need from biodiversity monitoring in Europe? The EuropaBON project consulted with more than 350 expert stakeholders from policy, research and practice to determine their needs from biodiversity monitoring in Europe. Our assessment shows a fragmented monitoring landscape that cannot easily answer all relevant policy questions now or in the near future. Challenges range from insufficient financial resources, taxonomic biases and lack of experts to inaccessibility of raw data. Proposed solutions include

standardization of data gathering, capacity building and stakeholder engagement, modeling and novel technologies, and enhanced coordination. Finally, we will articulate how biodiversity data is currently being used by policy and what the biodiversity monitoring requirements for addressing the main policy questions and goals are.

Reviewing across knowledge systems for better conservation: the case of the 'Gourmet omnivorous' pigs

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Traditional ecological knowledge (TEK) and collaborative research is increasingly acknowledged; conservationists and scientists work together with local knowledge holders for better and fairer conservation management. Experience shows that working with locals and the use of evidence from both knowledge systems can considerably improve conservation. Detailed cross knowledge system reviews of the available evidence are, however, still scarce. We studied extensive pig keeping in forests and marshes, a historically widespread but nowadays almost extinct practice in Europe. We focused on three knowledge areas: what, when and how pigs forage. We reviewed five knowledge sources: living TEK, ethnographic literature (archived TEK), pig and wild boar scientific literature, and authors' observations of foraging. Archived TEK differed much from living TEK. Scientific knowledge on wild boar foraging poorly correlated with living TEK. Variations in the contributions of the knowledge sources to the bigger picture were beneficial in widening the scope of our review, and were caused mainly by their different interests and methods used. We met several challenges of cross knowledge system reviewing. The unexpected dissimilarity of living and archived TEK and science points to the need to help the continuing existence and to an ongoing documentation of living traditional knowledge in Europe.

Rebuilding green infrastructure in boreal production forest given future global wood demand

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Global policy for biodiversity conservation is ultimately implemented and evaluated at landscape scale. In parallel, green infrastructure planning needs to account for socio-economic dynamics at national and global scales. We constructed scenarios of future landscape-scale forest management that account for global socioeconomic developments under a middle-of-the-road Shared Socioeconomic Pathway (SSP) and evaluated their impact on forest biodiversity. Specifically, we studied the potential to rebuild green infrastructure in a boreal production forest landscape, that had been intensively managed for decades, while meeting the projected future demand for wood products. In a green infrastructure scenario, we optimized levels of national environmental quality (EQO) indicators, asking whether good indicator status actually benefits forest biodiversity (the responses of multiple species), whether it can be achieved given global demands on forest products, and at what economic cost (relative to targeting financial gains alone). We show how effects of global SSPs can be downscaled and accounted for in planning landscape-scale forest and conservation management. Accounting for EQO in the management optimization can reveal scenarios for reaching targets on both revenue and conservation. Rebuilding green infrastructure

in the production forest was possible at a relatively minor economic cost and to the benefit of species of conservation concern.

Mapping and making current European monitoring initiatives accessible via a web-based database

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The EUROPABON biodiversity database (monitoring.europabon.org), is a web-based platform explicitly describing current workflows of monitoring efforts delivering biodiversity information in Europe. This database is a key tool to understand how biodiversity data collected in monitoring schemes across Europe flows through different institutions and programs and gets processed to produce Essential Biodiversity Variables (EBVs), Ecosystem Services Variables (EESVs) and /or other European policy-relevant indicators.

For a given monitoring network, the database collects information about three distinctive elements: 1) the biodiversity data collected in monitoring programs (e.g. taxa, spatio-temporal resolution); 2) the "integration nodes": platforms/projects/institutions processing the biodiversity data to generate EBVs, EESVs or any other indicators (e.g. funding available, type and spatial level of data processing) and 3) data flows (e.g. flow frequency).

Preliminary analyses of the database suggest, most integration of biodiversity data at the European level is carried out by non-governmental bodies and that there is a geographic and taxonomic bias in monitoring efforts across Europe, with data on plants and birds dominating over other taxonomic groups. Data from systematic monitoring programs are most commonly integrated to generate EBVs, EESVs and indicators at the European level; however, only a small fraction of these data is open access.

Introduction of large herbivores restored plant species richness in abandoned dry temperate grassland

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An increasingly practiced way of managing habitats with conservation value is naturalistic grazing by large herbivores. Their (re)introduction has the potential to restore and enhance biodiversity, creating self-sustainable environments vital for organisms requiring regular disturbances to moderate successional changes. European bison, Exmoor pony, and Tauros cattle were introduced in 2015 to a former military training area in Milovice, Czech Republic. The prevailing vegetation type is a forest-steppe savanna with *Bromus erectus*-dominated xeric grasslands mixed with deciduous shrubs and trees. After the cessation of military use, the area was abandoned which led to successional changes, including the dominance of tall grasses, litter accumulation and bush encroachment. In 2017–2021, we monitored grassland vegetation in 30 grazed permanent plots (2×2 m) and 5 control plots representative of ungrazed, abandoned vegetation adjacent to the grazed areas. Naturalistic grazing increased species richness and the cover of forbs, while the cover of grasses and legumes was minimally affected. Grazing promoted a compositional change to small statured species and an increased incidence of red-list species. Seven years of continuous grazing increased the conservation value of this forest-steppe vegetation, a habitat type rapidly declining in Europe.

Bridging the gap: How can genetic analysis translate to conservation action in the Eurasian lynx

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Population genomic methods allow for better estimates of key features of wild populations: including effective population size, inbreeding, demographic history and population structure. These estimates can inform ongoing conservation efforts, however, the gap between researchers and practitioners can make integration of scientific results into clear actions difficult. Using the Eurasian lynx as a case study, I will show how population genomic analyses can translate into clear conservation action, providing a framework for future projects. The Eurasian lynx is a large carnivore, which became locally extinct in Central Europe in the 20th century and has since been reintroduced in several countries beginning in the 1970 s. We investigated how re-introduction has shaped the demography of isolated Eurasian lynx populations, finding evidence of a strong founder effect and high levels of recent inbreeding in several populations. Our results indicate that reintroduced populations are vulnerable to the negative effects of inbreeding and small population sizes and conservation action will be needed to reach the overarching goal of a self-sustaining populations in the long term. These results have been integrated into management strategies, at a national and international level, involving newly planned translocations for the hopeful establishment of a European metapopulation of Eurasian lynx.

Testing Key Biodiversity Areas Criteria on Amphibians and Reptiles of Italy

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The Key Biodiversity Areas (KBA) approach, although relatively new and unexplored, is rapidly becoming an important method to identify regions of the planet hosting unique biodiversity. KBAs are identified through the implementation of standardized threshold-based criteria, which can be applied regardless of the target species and region. We developed a moving-window based methodology to scan geographical regions and detect potential KBAs under multiple criteria for target taxa. We tested the methodology on selected species of reptiles and amphibians in Italy and evaluated the response of different KBA criteria. Potential KBAs were identified for multiple species under most tested criteria. Unit size of the moving-window grid used to identify KBAs played an important role in shaping the distribution of potential KBAs, also affecting the degree of overlap between areas triggered by different criteria. New identified potential KBAs are only partially nested within current KBAs in Italy and within the national protected areas. The new methodology can be used for assessments of target taxa to identify potential KBAs. Evaluating species response to the KBA criteria can deepen our understanding of the KBA approach and how it can be improved to increase its contribution to the conservation of Earth's biodiversity.

Coping with environmental change: Are migrants particularly vulnerable?

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Organisms are increasingly exposed to rapid changes in the environment, yet it remains difficult to predict their responses to such changes. Migratory birds are considered to be ecologically less flexible than resident species thus it may be hypothesized they are more vulnerable to altered conditions. If so, one may predict that migrants may be less able to cope with challenges in the environment than resident congeners. To test this prediction, migratory and resident subspecies of the White-crowned Sparrow (*Zonotrichia leucophrys gambelii*) and (*Z. l. nuttalli*) were examined in cognitive, behavioral and physiological tests and the following variables were measured: (1) risk tolerance (i.e. flight initiation distance); (2) problem-solving ability; (3) object neophobia; (4) spatial exploratory tendency; and (5) adrenocortical stress response. All tests, except the exploratory test, were conducted in the non-breeding season. In support of the prediction, migrants

were found to be more risk-averse and less innovative in accomplishing a feeding task but did not differ in their response to novel objects, novel space or capture and restraint stress. These results suggest that migrants may be more constrained in their ability to cope with human disturbance and exploit emerging novel resources.

Impacts of community forest managed areas on deforestation and forest fragmentation during a political crisis in Madagascar

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The majority of the world's tropical forests are located in fragile nations that have suffered repeated political crises. Given the importance of tropical forest ecosystems for biodiversity, climate mitigation, and livelihoods, it is critical to understand what kinds of conservation interventions are resilient during times of political crisis. We investigated the relative effectiveness of two conservation interventions: community forest managed areas (CFM) and national parks (MNP), in the island nation of Madagascar, a country characterized by globally significant biodiversity, high levels of deforestation, and repeated political crises. Using panel data on deforestation and forest fragmentation derived from remote sensing, we conducted statistical matching and a difference-in-differences analysis to isolate the causal impact of CFM areas and matched MNP during the political crisis. Preliminary results indicate that CFM areas performed worse than MNP in terms of reducing deforestation during a political crisis, but better in terms of reducing forest fragmentation. This unexpected result may be due to different threats experienced by CFM areas and MNP in Madagascar. If our results hold up to planned robustness checks, then our findings indicate that hybrid conservation approaches combining traditional government-managed MNP with community-managed areas might be the most resilient during times of crisis.

Conservation planning for species and nature's contributions to people

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There is an urgent need to protect key areas for biodiversity and nature's contributions to people (NCP). However, different values of nature are rarely considered together in conservation planning. We identified and compared priority areas in Europe for three values of nature: (i) biodiversity, represented by 785 terrestrial vertebrate species; (ii) regulating NCP, represented by carbon sequestration, air quality regulation, flood prevention and pollination; and (iii) cultural NCP, represented by heritage forests, heritage agriculture, foraging for wild foods (mushrooms and plants), and nature tourism. We quantified the spatial overlap between these priorities and their performance in representing different values of nature. We found that different priorities rarely coincide, except in certain irreplaceable ecosystems. We also identified priority areas given what is already protected by the Natura 2000 network, which covers about 20% of the EU. We found that Natura 2000 protects 30% of the key areas for NCP, and 36% of vertebrate species distributions on average. Our results show that protecting an additional 5% of land has the potential to double conservation gains for biodiversity while also maintaining some essential NCP, leading to co-benefits for both nature and people.

Integrating big animal tracking data at a continental scale for assessing the potential of Eurasian lynx recovery across Europe

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The comeback of large carnivores in Europe provides unique opportunities for restoring biodiversity and missing ecological functions, yet coexisting with carnivores in shared landscapes remains a key conservation challenge. Fostering viable metapopulations of large carnivores across Europe requires knowledge about potential habitat for range expansions, as well as on how large carnivores can adapt to living in human-dominated landscapes. We analyzed these questions for the Eurasian lynx (*Lynx lynx*) integrating continent-wide animal tracking data (450 individuals across 13 countries). Using this unique dataset, we (1) compared approaches for large-area yet high-resolution habitat mapping and (2) assessed how lynx adjust their habitat selection in response to varying human pressures and landscape composition. We highlight that robustly mapping wildlife habitat at a continental scale requires accounting for regional variation in habitat selection across environmental gradients. Moreover, we show that human pressure is a main driver of variation in lynx habitat selection, determining the use of habitat features providing protection from human disturbance (i.e., forests or rugged terrain) and that such refuge habitats are essential for promoting coexistence, allowing lynx to persist in human-dominated landscapes. Together, our findings provide important new insights for the continent-wide conservation of lynx and large carnivores more generally.

Effects of livestock grazing in temperate forests – Historical knowledge enhancing present scientific understanding

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Forests have been grazed by livestock for centuries and there is an increasing recognition that, if done considerably, this incriminated activity can benefit forest management and biodiversity, maintaining a cultural practice providing benefits for local communities. We reviewed both current scientific literature (Web of Science) and historical traditional knowledge (Carpathian Basin, prior to mid-20th century) in order to assess the contemporary relevance of traditional silvopastoral practices to biodiversity management. We identified 71 recent, and over 160 relevant historical publications. Over 900 historical records present the practice of forest grazing, including cattle and sheep used for weed control in plantations, facilitating regeneration of target tree species. Pigs were used to prepare the soil for acorns, favouring oak regeneration. Reported effects varied greatly depending on forest type and stocking levels, livestock species and age, availability of alternative forage, grazing season, herder precaution and other activities taking place in the forest. Effects relevant from a conservation perspective include increased patchiness and habitat diversity resulting from a reduction in the cover of monodominant shrubs and pioneer vegetation, leading to an increased diversity of herbaceous vegetation. We urge the use of historical literature as a complementary source for developing tradition-based innovative conservation management methods.

Ecosystem Services from Urban Sacred Natural Sites

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Urban sacred natural sites, found globally, are important green spaces that provide a variety of ecosystem services, including cultural and ecological benefits. They are under increasing pressure due to the impacts of urbanization, while at the same time being needed more than ever. They provide both spiritual values as well as ecosystem services such as pollution control. One key example is Krakus Mound in Poland. This and other cases of urban sacred natural sites will be presented and compared, including those in Europe and beyond, such as Swayambhu, Nepal, Meiji Jingu, Japan, and Ambohimanga, Madagascar. Despite a wide diversity of associated faith traditions, some common features of these sites include sacred species of trees

and symbolic boundary markers. Several of the locations have been declared World Heritage Sites, which has resulted in increased tourism. Future conservation efforts should take into account the diversity of managers and associated management systems for these sites, as well as their multiple users, ranging from participants in associated ceremonies to tourists to city residents.

SUPPLEMENTAL FEEDING AND ANIMAL MOVEMENT: ECOLOGICAL CONSEQUENCES OF A WIDESPREAD MANAGEMENT PRACTICE

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The heterogeneous distribution of resources can influence individual movement and space-use patterns. We investigated behavioral and spatial responses of European roe deer (*Capreolus capreolus*) to supplemental feeding, a widespread management practice that alters resource distribution by artificially providing abundant and concentrated food. We firstly analyzed roe deer spatial responses by experimentally manipulating feeding site accessibility, finding that these resource alterations drove shifts in roe deer movements and space-use, mediated by both individual resource preferences, and site familiarity. We also demonstrated that roe deer relied on memory, not perception, to track the spatio-temporal availability of these resources. Then, we examined the environmental and behavioral drivers influencing roe deer use of feeding sites, finding evidence for both a seasonal and circadian cycle in the pattern of visits that was further influenced by competition of conspecifics. Finally, by contrasting these patterns during and before the COVID-19 Anthropause, we linked the aforementioned patterns of use of feeding sites to risk perception by roe deer. By applying movement ecology principles and techniques, we showed that this management practice importantly affects individual space-use and behavior, with potential detrimental unintended effects on the target populations that deserve further investigation.

Coping with the challenges of human-wildlife conflicts in the 21st century. Is coexistence just a dream of nature lovers?

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Agricultural landscapes increasingly become arenas of conflict in which human and wildlife compete for the same resources. Designing sustainable strategies requires balancing two apparently diverging goals: (mainly economic) interests of farmers, and conservation of protected species and/or habitats. We present multiple human-wildlife conflict examples from Germany:

- expansion of gray wolf populations vs. livestock depredation,
- changing migratory flyways of cranes vs. crop damages,
- recolonization of mega-herbivores such as European bison and moose vs. (yet) unknown damages,
- outbreak of African swine fever in wild boar vs. fencing activities.

These examples suggest that the damage mitigation measures to protect the economic interests of farmers conflicts with legal conservation frameworks. This discrepancy is manifested in opposing stakeholder interests, and causes human-human conflict. Integrated impact assessment can be used as a tool to identify trade-offs and to assess alternative policy measures and management options and their likely effects on humans and wildlife. The concept of human-wildlife coexistence provides a holistic framework in which social and economic aspects of people and ecological needs of wildlife are considered in an integrated way. We illustrate examples of integrated impact assessment for human-wildlife interaction and discuss ideas for policy and management implications.

Forecasting future range shifts to an endangered freshwater mussel in Europe: the importance of considering biotic interactions

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The freshwater pearl mussel *Margaritifera margaritifera* has been suffering major population declines in Europe. This endangered species is a host specialist and exclusively requires salmonid species (*Salmo trutta* and *Salmo salar*) to complete its life cycle, demanding a special conservation attention, particularly under future climate change. To evaluate the importance of including the occurrence of fish hosts for predicting the current and future distribution of *M. margaritifera* in Europe, three datasets were used to build species distribution models (SDMs) with a maximum entropy (MaxEnt) approach: (1) environmental variables; (2) probability of fish hosts occurrence; and (3) environmental variables and probability of fish hosts occurrence. Projections were also used to evaluate the adequacy of current networks of European protected areas in covering suitable habitats. Incorporating data about fish hosts into *M. margaritifera*'s SDMs avoided the overprediction of geographical projections. While predictions indicated large contractions in *M. margaritifera*'s distribution as a result of future climate change, the current European network of protected areas fails to safeguard its habitats. SDMs can inform political decision-making about the likely scenarios for species occurrence in future decades, the requirements needed for an effective conservation strategy, and the regions where conservation should be a priority.

Effects of land-tenure regimes on deforestation in Brazil

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Many tropical forestlands are experiencing changes in land-tenure regimes, but how these changes may affect deforestation rates remains theoretically and empirically ambiguous, hampering generalizations on the most likely long-term effects of land-tenure policies and interventions. Using Brazil's uniquely comprehensive compilation of land-tenure data and quasi-experimental study design, we estimated the effects of six alternative tenure regimes on deforestation from 1985–2018. We tested the consistency of these findings across regional-historical contexts by creating quasi-repetitions over 49 spatiotemporal scales. Our results indicated that poorly defined public tenure increased deforestation relative to any alternative regime in most contexts. Private tenure often reduced this deforestation, but did so less effectively and less reliably than alternative well-defined regimes, except for in remote regions where on-the-ground governance is limited and there are extensive environmental policies. Directly privatizing conservation regimes or indigenous lands, in turn, would likely increase deforestation. Our cross-scale synthesis informs how conservation, titling, and other tenure-intervention policies may align with climate-change, biodiversity, and broader environmental sustainability goals; and are directly relevant to ongoing political debates regarding land privatization and/or protection in Amazonia.

Validating forest biodiversity indicators with multi-taxonomic data: An Europe-wide analysis

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Most forest biodiversity indicators are based on existing data from national forest inventories. They have been used for several decades to assess the state and dynamics of forest biodiversity, notably through Forest Europe's initiative and reportings. Although valuable, these indicators are essentially indirect and evaluate habitat quantity and quality rather than biodiversity per se. Therefore, their link to biodiversity may be weak, which decreases their usefulness for decision making for biodiversity conservation.

Within the framework of the COST Action Bottoms-up CA18207, we gathered data on multi-taxonomic biodiversity and forest structure across more than 3 000 plots in Europe. We hypothesised that no single biodiversity indicator from Forest Europe is able to represent all biodiversity, but that several indicators would reflect habitat quality for at least some taxa in a rather comprehensive way (e.g. saproxylic species).

While these indicators have been chosen for their availability and the fact that they are understandable to most, our analyses show that there are still gaps in the monitoring framework, and that monitoring certain taxa (groups, species) along with stand structure is necessary to support policy making and tackle forest biodiversity loss at the large scale.

Ecosystem services, conflicts, and well-being impacts: A forest restoration project along the river Drava at the Croatian-Hungarian border

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The Lankoc Forest, situated along the river Drava at the Croatian-Hungarian border, is one of the last remnants of species-rich alluvial forests. A water retention project was initiated in 2018 by WWF Hungary to halt the loss of biodiversity induced by the dropping water table and the extreme weather events. While the improved water regime could benefit both the private forest owners and the state forestry by increasing ecological resilience and timber quality, conflicts arose when local stakeholders were informed about the water retention plan. During 2020 and 2021, a stakeholder and conflict analysis, a qualitative ecosystem services assessment, and a participatory scenario building process were carried out to better understand the stakeholders' views, potential divergences and to allow win-win solutions to emerge. The research highlighted diverging perceptions of ecosystem services across key stakeholder groups, provisioning services being more important to those who make a living from the forest, while regulating and cultural services prioritised by citizens or visitors. In addition to the conflicting interests, interviews also revealed structural and value-laden roots of the conflict. Better communicating and distributing the project's social and cultural benefits to the wider local community can be a way forward to increase its acceptance.

(How) can the EU Common Agricultural Policy still address the crisis of farmland biodiversity?

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The EU's Common Agricultural Policy (CAP) hasn't succeeded in halting farmland biodiversity loss. The CAP post-2023 offers a new 'Green Architecture', including 'Eco-schemes', that can potentially address this weakness. Over 3,600 scientists called the EU to be more ambitious, and over 300 experts delivered recommendations on how the CAP could do better for biodiversity.

Key principles for success include: preserving and restoring (semi-) natural elements and extensive grasslands; improving spatial planning and landscape-scale implementation, e.g. via collective actions; implementing result-based approaches; and improving knowledge exchange. The reality, however, is that the war on Ukraine has revived the food security narrative, leading the EU to open fallow land to production, and shifting budgets to Pillar 1 to expand the use of agrochemicals. Overall lack of ambition is demonstrated also by the National Strategic Plans submitted to the Commission.

There is much work for the Commission and Member States to improve Eco-schemes' design, as well as the CAP's overall implementation. Transparency and greater involvement of scientists (and farmers!) is imperative, as is the need to identify and address sources of resistance to transformation.

We should also think beyond 2027: if Direct Payments cannot be phased out, other policy instruments should be sought.

Essential Biodiversity and Ecosystem Service Variables as a powerful tool to overcome current monitoring roadblocks

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Essential Biodiversity Variables and Essential Ecosystem Service Variables, a framework initially conceptualized by GEO BON, have a large potential to increase standardization and harmonization of data collection while enhancing modeling efforts. In collaboration with hundreds of experts from research and policy, we identified a set of variables essential to monitor in Europe. These EBVs and EESVs can help address key policy questions while being of high scientific relevance.

Natural enemy diversity stabilizes biological pest control via enhanced species asynchrony

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Land-use changes associated with agricultural intensification reduce the diversity of natural enemies with potential consequences on the level of natural pest control. Few studies, however, have explored how these landscape-driven changes in natural enemy diversity influence the temporal stability of biological control (i.e., the inverse of variability) and the underlying mechanisms. Using a global database of natural enemies and biocontrol studies collected from 1180 crop fields, we found that species asynchrony—more than the temporal stability of dominant species and species diversity per se—is the main driver of temporal stability of biological control. Landscape simplification had relatively weak negative effects on biocontrol stability either indirectly by reducing natural enemy diversity, or directly by increasing the temporal variability in natural enemy abundance. We conclude that high species diversity via enhanced asynchrony is critical for ensuring stable biocontrol services under varying landscape contexts.

Biodiversity post-2020: Closing the gap between global targets and national-level implementation

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National and local governments need to step up efforts to effectively implement the post-2020 global biodiversity framework of the Convention on Biological Diversity to halt and reverse worsening biodiversity trends. In this talk, we propose a framework for improved implementation by national and subnational governments, drawing on recent advances in interdisciplinary biodiversity science. First, the identification of actions and the promotion of ownership across stakeholders need to recognize the multiple values of biodiversity and account for remote responsibility. Second, cross-sectorial implementation and mainstreaming should adopt scalable and multifunctional ecosystem restoration approaches and target positive futures for nature and people. Third, assessment of progress and adaptive management can be informed by novel biodiversity monitoring and modeling approaches handling the multidimensionality of biodiversity change.

Enhancing weed multifunctionality through landscape-scale management

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Arable weeds have drastically declined over the last decades, yet, even if they can have detrimental effects on crop production, weeds are of key value for the maintenance of biodiversity and the delivery of pollination and pest control services in agroecosystems. Agroecological weed management should thus aim at maintaining weed diversity, preventing weed outbreaks while reducing herbicide use. Local management practices and properties of the wider landscape can contribute in combination, rather than separately, to achieving this aim. They can directly shape the composition of weed communities, and, indirectly, promote organisms that regulate weeds. In this talk, I present a framework to assess the multifunctionality of weed communities in real landscapes and show how the compositional and configurational heterogeneity of crop mosaics can create interesting trade-offs between weed services and disservices at a landscape level. I also present results illustrating how the interplay between field-scale management and landscape properties can affect weed seed predators and ultimately the biological regulation of weeds. Both examples highlight the benefits of diversifying landscapes and farming management for biodiversity and the delivery of ecosystem services.

What is an eco-evolutionary conservation ethic and why do we need one?

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Natural scientists have largely been responsible for identifying our current environmental crises of climate change and mass extinction. They have also been responsible for naming the Anthropocene. Many would also argue that natural science, by fostering Cartesian dualism, is in fact partly to blame for the Anthropocene in the first place! Regardless, natural science is going to play a key role in informing human actions and the future of humankind (and hence the biosphere) in the geological near-term. Thus, it is important to reach natural scientists in terms of conveying the importance of our moral obligations to nonhuman nature. Supposed objectivity in natural sciences, however, often precludes the possibility of even opening a dialogue about what scientists ought to do. Scientific textbooks on evolution warn against the dangers of anthropomorphism – yet Darwin himself was at pains to reveal expressions and emotions of animals, and postulated that our moral sense is indeed evolved from the social instincts of animals. Our evolutionary kinship with nonhuman nature is the foundation of an eco-evolutionary conservation ethic that may allow natural scientists to develop an ecocentric worldview. By no means the only path to ecocentric enlightenment, a natural-science based ethic is nonetheless important precisely because of the role

that science plays in informing policy. Ecocentric worldviews, through recognition of the intrinsic natural value of organisms, species and ecosystems, are the foundation for the rights of nature. I will present a short overview of the development of ecocentrism in western philosophical thought, give my interpretation of an eco-evolutionary ethic, and suggest ways in which it can be put into practice.

Understanding spatio-temporal dynamics of returning wolves to Germany

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After centuries of extirpation, wolves are now recolonizing the human-dominated landscape of Germany. This represents a major challenge for wildlife management and conservation, including increasing human-wildlife conflicts. Limited data and non-stationarity responses to habitat selection in expanding populations pose significant challenges to reliably predict wolves' range expansion and suitable areas for conservation. We used the natural experiment of the recent wolf expansion into Germany from the past 20 years, combining telemetry with territory monitoring data. We compared predictions from models representing spatio-temporal colonization steps with a global ensemble model that used all data. Models for different colonization steps differed substantially from the global model, showing individuals in newly colonized areas select for areas with lower human disturbance. This cautions against extrapolating habitat models in space based on data from initial colonization phases, when species are out of equilibrium with their environment. To further understand the expansion process, and based on the global suitability map, we developed an individual-based model accounting for population demographic, dispersal and settlement processes, which shows bottlenecks in range expansion and gives a temporal horizon of recolonization. Our modelling approach highlights the importance of explicitly accounting for non-stationarity in habitat selection and demography when modeling range-expanding carnivores.

Harnessing the push-pull technology for biodiverse agroecosystems in East Africa: the UPSCALE project

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The push-pull technology is a mixed cropping system practiced in smallholder tropical cereal farming in areas of East and Central Africa. Push-pull systems harness the chemical interactions of companion plants and insects to provide highly effective pest protection and yield enhancement of crops. In this talk I will present the EU Horizon 2020 project UPSCALE which is working to upscale the push-pull technology for sustainable agricultural intensification in East Africa and beyond. Major focal points of the project include investigation of how landscape-level factors influence the effectiveness of push-pull systems, how increases in the landscape-level amount of push-pull cropping influences arthropod communities within and outside crops, and how transdisciplinarity can help to address key bottlenecks for the implementation of push-pull practices at scale. From this I will discuss and highlight key knowledge and practice gaps for the broader expansion of biodiversity-enhancing intensification practices in tropical agroecosystems.

FROM CITIZEN SCIENCE DATA TO POLICY IMPACT ASSESSMENT: AN INTEGRATED MODELLING APPROACH TO CALCULATE THE FBI IN AGRICULTURAL POLICY SCENARIOS

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The purpose of this presentation is to introduce the recently completed work that aimed to develop an integrated robust methodology by embedding the Farmland Bird Indicator (FBI) – one of the most consolidated Common Agricultural Policy indicators for years – into the agricultural economic model CAPRI. This methodological development may then be used to assess the impact of the CAP and other policies on conserving relatively common and widespread farmland birds. Using data from the Pan-European Breeding Bird Monitoring Scheme over the period 1990–2013, our analysis focuses on finding the relations between changes in farmland bird populations and changes in agricultural practices, within four macro-regions. These relations are then linked to changes in agricultural production activities and common reporting indicators from CAPRI such as, crop shares, nitrogen input, livestock density, resulting from policy change scenarios. Projections from the models are derived first to assess the predictive power of the model within each macro-region. We then use the species predicted abundances to calculate the FBI at different spatial scales. By testing the FBI performance in a scenario assessment exercise, it is possible to assess, for example, to which magnitude of changes the FBI is responding.

EU Forest and Biodiversity Governance

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This talk sets out the context of governance for EU forest and biodiversity policy-making in three ways: It discusses (a) synergies and trade-offs between different policy areas, (b) consequences of target accumulation and (c) potential for policy coordination and integration

Factors influencing the allocation of international conservation efforts

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International funding for conservation has grown over the last decades. Yet, much uncertainty remains about what factors affect such decisions – particularly at the subnational level and between major donors. Five considerations are often mentioned in literature and grant descriptions: 1) conserving areas with more environmental assets (species, carbon, water); 2) conserving areas with higher level of threats, 3) conserving areas where the cost is low, 4) conserving areas steward by Indigenous people and local communities (IPLC), and 5) conserving places with previous investment (agglomeration effect). Using a georeferenced database of 1160 internationally funded projects related to conservation in South America's major deforestation frontiers, we examined the influences of the aforementioned considerations on the level of funding committed to an area. Our results showed that funding has been committed to areas with higher species richness and higher carbon density, but not as much to places with higher water provision importance. Cost and previous investments influenced funding allocation more than deforestation threats or the existence of IPLC. We further showed the factors influencing the distribution of foreign conservation funding from major donors, and discussed the implications for more targeted strategies to improve the resource allocation for conservation.

Diversified farming at field- and landscape scale for biodiversity and ecosystem services

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Agricultural intensification has led to homogenous landscapes characterised by vast fields of monocultures of few high-yielding crops grown in short rotations. The lack of diverse food and habitat resources in these landscapes has contributed to a stark decline of biodiversity. Here we assessed the potential for diversified farming systems at multiple spatial scales to promote pollinators, natural enemies of pests and the ecosystem services they provide. At landscape scale, we found that higher crop diversity (i.e. increasing the number and evenness of crop types grown) promoted bumblebee densities. Carabid beetle species richness was higher in landscapes with high crop diversity in the previous year, suggesting positive legacy effects of crop diversity on carabid beetles. At field scale, annual flower strips supported spiders in adjacent arable fields. Adding flower strips also promoted bumblebee queen abundance in the landscape in the subsequent spring, yet this positive legacy effect of flower strips was diminished in landscapes with added honeybee hives. We argue that these diversification strategies are valuable management approaches in providing more resources for wild biodiversity. Legacy effects of diversification strategies remain rarely considered, yet are crucial in understanding effects on biodiversity conservation, population growth, ecosystem functioning and crop production over time.

The use of grazing for biodiversity and ecosystem management in marginal farmland areas

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The abandonment of marginal farmland across the Mediterranean is leading to an increase in shrub encroachment, which may result in habitat homogenization and increased wildfire risk. This study investigated the performance of different grazing regimes in regulating fire prone vegetation, supporting biodiversity conservation, and to identify and deliver cost-effective solutions for ecosystem management. Specifically, three grazing regimes (extensive cattle grazing, semi-wild horse grazing, and no grazing) were assessed at three case-study sites in Portugal. Overall, non-grazed sites showed higher shrub connectivity at the landscape level, had a more complex vertical structure and larger proportion of tall grasses, which increases the risk of wildfire. Semi-wild grazing showed positive but limited contribution to wildfire prevention, which may require additional management measures, while extensive grazing (with additional feeding) created vertical fuel discontinuity, reduced fuel loads, and supported high species richness, showing, on the other hand, impact in tree recruitment and suggesting the need for protective measures. The performance and suitability of grazing regimes, and their combination, will also depend on local environmental conditions and management goals. Ultimately, where wild herbivores' density is low, semi wild and/or domestic herbivores in extensive regimes can help regulate fuel loads and maintain habitat diversity.

Are mass-flowering crops beneficial or detrimental for the conservation of wild pollinators?

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Insect pollinator species declines in agroecosystems are concerning, and addition of floral resources to sustain pollinators is encouraged in agri-environmental schemes. The amount of floral resources in agroecosystems can be increased by growing mass-flowering crops (MFC). However, the benefit of MFC on insect pollinator densities and species richness seem context-dependent. In this presentation, we

show the effects of MFC on insect pollinators in a case study and in a meta-analysis.

From a case study in Sweden, we found greater bumblebee species richness following bloom of mass-flowering red clover. The results indicate that late flowering MFC offer food resources during a time when these are scarce and that this has a potential to benefit less common bumblebee species.

On the other hand, a meta-analysis shows that increasing MFC cover generally has negative effects on wild pollinator densities and species richness, predominantly in crop habitats. No evidence was found of pollinator spill-over from crop to non-crop habitats after MFC bloom. From our findings, we conclude that only the densities of a few pollinator species adapted to the flowering crop benefit from MFC. Therefore increasing the cultivation of MFC will not ensure conservation of pollinator species.

Using global scenarios of phylogenetic diversity to design conservation priorities

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Various prioritisation strategies have been developed to cope with accelerating biodiversity loss and limited conservation resources. These strategies could become more engaging for decision-makers if they reflected the positive effects conservation can have on future projected biodiversity, by targeting net positive outcomes in future projected biodiversity, rather than reflecting the negative consequences of further biodiversity losses only. Hoping to inform the post-2020 biodiversity framework, we here apply this approach of targeting net positive outcomes in future projected biodiversity to phylogenetic diversity (PD) to reidentify priority areas for conserving global mammalian PD. We identified two types of priority areas: those whose protection would maximise gains in future projected PD and those where extinction(s) would maximise losses in future projected PD. We show that these two types of priority areas differ from each other, and generally differ from previously-identified ones for global mammal conservation. We further highlight that these newly-identified species/areas of interest currently lack protection and offer some guidance for their future management.

Ecological insights gained in over 15 years of European bison grazing in the coastal dunes of Kraansvlak, the Netherlands.

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Abandonment of extensive grazing, increasing nitrogen deposition and decline of rabbit populations over the last decades have led to vegetation encroachment of the dune landscapes throughout the Netherlands. To counteract this overgrowth of vegetation, grazing with large herbivores has been widely embraced in nature areas across the Netherlands. Mostly cattle and horse breeds have been chosen to roam year round.

In the National Park Zuid-Kennemerland, located in the North-Western coast of the Netherlands, a similar approach was taken. Semi-free roaming cattle and horses were introduced to restore the dunes. However, uniquely and for the first time in the Netherlands, in the Kraansvlak dune area (also part of National Park) it was chosen to run a pilot to investigate the role of European bison in the dune ecosystem under natural semi-free living conditions. Ever since the first European bison were released in Kraansvlak in 2007, active research and monitoring have taken place. Along the years, konik horse and highland cattle have been added to the herbivore assemblage of Kraansvlak, giving unique chances to study the three large herbivores together. Feeding ecology, impact on vegetation as well as habitat selection and habitat use have been major focus of attention.

Trends and dynamics in conservation culturomics and iEcology research

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Recent years have seen the formulation of the fields of Conservation Culturomics and iEcology. Consequently, there has been a sharp increase in scientific papers dedicated to these fields. Nevertheless, many publications are still unaware of these formulations, their growing body of dedicated publications, and recent advances. Here, we aimed at exploring trends in papers dedicated to these fields to elucidate their various attributes and trends, their underlying data sources, methods employed, and citation network features. To this end we collated research papers dedicated to conservation culturomics and iEcology using an array of potentially relevant keywords. We assembled their attributes and constructed their citation network. We found that while many papers share a citation network there are distinct clusters of publications centered on particular framings of these fields. Social media and webpage analytics were the most common corpora explored. Topics covered by these papers were varied including: elucidating people's interest in species, wildlife, and nature in general; monitoring interest in environmental and conservation issues; studying provisions of cultural ecosystem services; obtaining data for species distributions; topics in invasion biology, and others. Overall, conservation culturomics and iEcology could benefit from popularization and greater clarity of scope, definitions, and improved scientific collaborations.

Effects of village modernization on biodiversity – urbanization in rural areas.

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Villages are biodiversity rich environments, yet they have received little attention in the context of farmland biodiversity conservation. Similarly, being a type of urban habitat, they have been rarely studied in urban ecology. A substantial component of farmland bird declines come from species linked to human agricultural settlements, and these areas have undergone radical changes due to modernization in the past 50 years. We performed a large-scale study to disentangle the relative impact of two widespread ongoing processes in rural landscapes: village modernization and agricultural land-use intensification. We investigated abundance and species richness of farmland birds in 104 villages and their surrounding crop environments in Poland. Model predictions showed that highly modernized villages and their surrounding agricultural fields had 50–60% fewer birds than those in and around comparable older villages. The relative contribution of modernization versus agricultural intensification to predicted reduction in bird abundance was 88% vs. 12% for birds in villages and 56% vs. 44% in surrounding crops, with high variation among ecological species subsets. Conservation of important habitats linked to villages and rural settlements needs to be urgently developed and included in European Green Deal, Common Agriculture Policy and program for rural development.

The effects of ecosystem restoration on soil biota: 5-year data from a BACI experiment in forested wetlands

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Globally, restoring degraded wetland ecosystems is a major topic. Restoring soil is a fundamental part of that, but it is addressed indirectly (e.g., by hydrological restoration) and actual measurements of the biotic responses in the soil are scarce. We studied the response of fungi and bacteria to ecosystem restoration activities in a large scale BACI experiment in bog forests in Estonia, hemiboreal Europe. The field treatments combined ditch closure and partial cutting to restore the original water level and stand structure. The soil samples and environmental data were collected before and four years after the treatments, the soil samples were sequenced for fungi and bacteria using Illumina MiSeq. The assemblages of both fungi and bacteria had a strong, rapid, but partly different response to ditch closure. The effect of partial cuttings was smaller. Within four years post treatment the assemblages became characterized by large yearly changes partly reflecting the annual water conditions, with no clear successional direction. We conclude that it is not obvious that hydrological restoration can reverse the soil succession in drained bog forests, and long term monitoring is needed.

The sacred commons: Conflicts and solutions of resource management in sacred natural sites

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Sacred natural sites are considered an additional pillar for biodiversity conservation, next to the protected areas network. However, sacred landscapes are not primarily conservation areas, but exist for cultural and social reasons. To evaluate their strengths and weaknesses as community-based conservation areas, a thorough understanding of the underlying values, institutional arrangements, and outcomes is required. I used institutional economics for a meta-analysis of publications on sacred natural sites to identify potential conflicts in their maintenance, and to analyse institutional arrangements to solve these conflicts. I show that most sacred natural sites resemble common-pool resources and that many design principles that are linked to common-pool resources are also found in traditional institutions managing sacred places. Design principles are no blue-print solution but they may guide future research to identify locally robust institutional arrangements that are linked to the ecological integrity of sacred natural sites.

How to encourage people to increase biodiversity in their gardens? An application of the Theory of Planned Behavior

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Private gardens cover a substantial amount of space in urban areas and thus they have an immense impact on urban biodiversity. Our study uses an extended version of the Theory of Planned Behavior, a widely used theory to explain human behavior, to identify factors that predict feature richness in private gardens (i.e., the number of plant and non-plant-based features that provide habitats for wildlife). Using survey data from 695 urban dwellers from four cities in New Zealand, we show that householders' intention to engage in wildlife gardening was associated with feature richness in their gardens. Attitudes towards the behavior, subjective norms, and perceived behavioral control as well as nature connectedness were significant predictors of the intention to engage in wildlife gardening practices. We conclude that the Theory of Planned Behavior, with nature connectedness as an additional predictor, is well suited to explain householders' engagement in wildlife gardening practices. Furthermore, we explored the beliefs that determine attitudes, subjective norms, and perceived behavioral control. Access to information and knowl-

edge had the strongest association with perceived behavioral control. Subjective norms were predicted by householders' normative beliefs about friends, family, and environmentalists. The findings can help develop effective interventions to increase urban biodiversity.

Alpine lynx populations need connectivity improvements for future self-sustainment

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Eurasian lynx (*Lynx lynx*) populations reintroduced in Europe in the 1970's stagnated in the 1990's and remain isolated until today. Mutual connectivity is essential for their long-term survival, which makes the Alps, due to their location and extensive suitable habitat, crucial for a Central European metapopulation. We used an individual-based spatially-explicit model to simulate five lynx populations in Central Europe until 2040 (Scenario 1), and the effect of 14 lynx reintroduced within the LIFE Lynx project (Scenario 2). We 1) assessed population viability and 2) connectivity under both scenarios; and 3) determined the Minimum Viable Population for a stepping-stone network within the Alps. Preliminary results show that, in both scenarios, the Jura population has the best chances of survival while the Dinaric is the most vulnerable, with extinction probabilities of 72 or 66%, respectively. Connectivity between core lynx populations was minimal. Still, reintroductions within the Dinaric population improved its survival and local connectivity. Finally, at least eight breeding pairs were needed for a stepping-stone. Our work highlights the fragility of the lynx Dinaric population. The slow natural expansion of lynx populations and the consequent lack of connectivity, reinforces the need to introduce genetic variability and promote gene flow between populations.

Effects of protected areas on biodiversity occurrence trends – a country-wise multi taxon evaluation

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Most studies evaluating impacts of conservation, e.g. protected areas, are taxonomically restricted, with a large bias towards vertebrates. Here, we apply a robust matching of protected and unprotected sites, and model species occurrence trends over several decades through joint species distribution modeling using long-term systematic survey data on forest understory plants, phytoplankton from lakes, birds and mammals collected across a whole country, Finland. Effect of protected areas (PAs) on species occurrence trends varied strongly between and within the higher taxonomic groups considered. Effect of PAs was broadly positive for mammals and phytoplankton, with a large proportion of species showing more positive trends inside than outside of PAs. For plants, we found no measurable effect of PAs, with most species showing no difference in trends within and outside of PAs. Conversely, birds had more negative occurrence trend inside than outside of PAs. Ecology and life-history strategies of the contrasting species and higher groups likely drive the observed patterns. These contrasting responses to conservation highlight the importance of considering multiple and contrasting taxonomic groups when assessing the potential effects of PAs on biodiversity.

Double advantages in monitoring biodiversity trends and threats using digital tools in the context of recreational fishing

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Mining data about recreational fisheries on social media can increase our understanding of potential threats of such fishing activity on biodiversity. At the same time, such data can contribute to understand

biodiversity trends and, most importantly, the ecological and social dimension of biodiversity changes in response to climate change. I will present three case studies where YouTube data mining about recreational fishing in the North-Western Mediterranean Sea demonstrated to be useful to: (i) document unexpected harvesting patterns of an iconic fish species that can provide crucial information for the conservation of the species; (ii) characterize macroecological patterns of groupers such as ontogenetic deepening and distributional range shifts, which can unveil climate change effects on these emblematic top predators of coral and rocky reefs; (iii) quantify polarized sentiments of recreational fishers towards an invasive species that is extending its distribution in response to climate change, thereby providing information for possible management interventions. In summary, digital tools in the context of recreational fishing can have a double and overlooked advantage in monitoring marine biodiversity trends and threats from an ecological and social perspective.

Strategic climate change litigation, science and the EU Habitats Directive: moving from adaptation to contestation?

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Against the backdrop of the rising temperatures, climate change lawsuits have recently emerged as a new lever in order to step up compliance with international climate pledges. As of today, the majority of these strategic lawsuits are based upon tort law and human rights duties. However, many ecosystems are already suffering from the global rise of temperatures, also in Europe. This chapter outlines the potential interplay between the existing protection and restoration duties that are included in the EU Habitats Directive and climate change. First, it is addressed to what extent the risks associated with climate change play a role throughout the designation process for endangered habitats and species. Second, it is analyzed whether the protection mandates could be reframed so as to encompass a clear-cut duty to limit CO₂-emitting activities that further jeopardize endangered habitats and species. Third, it is researched to what extent the restoration duties incumbent on the EU Member States could be used as a lever to designate and protect future climate corridor zones, that might be essential for the migration of vulnerable species affected by climate change. The overall conclusion is that the EU Habitats Directive will be at the forefront in future climate litigation.

Evaluating the effectiveness of surrogates for large mammal connectivity conservation

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Connected landscapes can increase the effectiveness of protected areas by facilitating individual movement and gene-flow between populations, increasing species persistence and ecosystem resilience. Connectivity conservation needs to be species-specific. Assessing it is often based on modelling connectivity for one or few surrogate species, with the assumption that the resulting network will be effective for co-occurring species. However, the selection and effectiveness of the surrogate at representing other species is rarely evaluated.

We present a framework to select surrogates for connectivity and evaluate their effectiveness for representing other species. We simulated connectivity networks for 24 large mammals among IUCN category I-IV protected areas and Natura2000 sites in continental Europe across 13 geographical biomes and 38 ecoregions. We devised an approach to evaluate which and how many species contribute the most towards pre-identified connectivity goals.

We found multiple species were necessary to meet connectivity goals across all scales and regions. The number, identity, and attributes of connectivity surrogates are sensitive to spatial scale and human influence on the landscape. We conclude that multiple species, selected in

relation to landscape characteristics, are essential to meet connectivity goals. We demonstrate a way to objectively select and assess the effectiveness of surrogates for connectivity conservation.

Access and Benefit Sharing in the Global Biodiversity Framework: How to Measure the Reciprocity for Nature?

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International law provides for mechanisms for the conservation and restoration of biodiversity resulting from utilising nature. One of the mechanisms that aims to generate funds and awareness for conservation is fair and equitable sharing of benefits arising from genetic resources (ABS). The success of ABS is measured through the global indicators such as the Aichi Targets. ABS is also an integral part of the Post 2020 Global Biodiversity Framework.

The Open-Ended Working Group on the Post-2020 Biodiversity Framework is in the process of negotiating the international biodiversity goals, targets and indicators which will be replacing the Aichi Biodiversity Targets. The negotiation will lead to the adoption of the Post-2020 Global Biodiversity Framework.

In 2020, the Global Biodiversity Outlook has announced that we have failed to achieve every single one of the Aichi Targets. Therefore, there is an apparent need to evaluate whether the Post-2020 Framework faces the same fate.

This presentation will compare the access and benefit-sharing related goals, targets and indicators of Aichi Targets with the Post-2020 Framework that will be adopted in May 2022 in order to discuss whether the success or failure of ABS can be measured through these frameworks.

Contribution of CAP data and remote sensing to the calculation of a biodiversity indicator for farmers, policy makers and other stakeholders

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The development of agri-environmental indicators is needed to monitor and support the transition towards more sustainable agricultural systems. It will be particularly critical for the next Common Agricultural Policy (CAP). However, the implementation of such indicators at regional, national and EU levels faces a major obstacle, which is the acquisition of relevant data at fine spatial and temporal resolution (e.g. at field level, every year) across large areas. The use of CAP data and satellite data, in particular high-resolution Sentinel images, represents a promising avenue to tackle this challenge. After a short review of the possibilities provided by CAP data and Sentinel images, we will present three agri-environmental indicators currently developed in the H2020 NIVA project: carbon budget, nitrate leaching and biodiversity. We will then focus on the biodiversity indicator, explain its scientific background, the method proposed to calculate this indicator, perspectives to improve this indicator. Finally, we will discuss how such biodiversity indicator could be used by different types of stakeholders, including farmers and policy makers.

A European series of forest stands of different ages and their multi-taxon biodiversity

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Changes in forest structure, composition, and management regimes over time affect the temporal variation of biodiversity. Therefore, the results from studies on forest biodiversity conducted at single time scales may not be transferable to all the development phases of a particular stand. When no experimental plots are available for long-term observations, artificial time series may be established by combining stands of different ages. Artificial time series have been used for recording the growth of even-aged stands to construct yield tables. We established a similar growth series of even-aged stands that included about 2000 plots distributed across Europe within the framework of the COST Action BOTTOMS-UP. This allowed us to assess the relationship between management regime, structure, structural diversity, species richness and abundance of several taxa over time. The results contribute to bridging the gap between the increasing amount of knowledge about stand structure processes and the information deficit in how multi-taxon biodiversity changes with them.

High throughput sequencing of microsatellites for ecological research – practical large-scale application to brown bears (*Urus arctos*) and beyond

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For many wildlife species, noninvasive genetic sampling is the backbone of abundance and distribution monitoring and is being increasingly included into routine monitoring programs. In most cases the markers of choice are microsatellites, which are in many aspects ideal for the purpose, but the way they're commonly analyzed is labor-intensive and subjective, making large studies and collaboration between laboratories difficult. An alternative using high-throughput sequencing has been recently proposed, and we applied it to several large studies of brown bears, analyzing 7916 noninvasive and 1971 tissue samples. The method proved to be efficient and cost effective, providing fast and reliable genotyping with low manual labor, making it easily scalable to large studies. Since genotypes are based on DNA sequences, they can be readily transferred between laboratories and will be independent from the DNA sequencing technology used in the future, fostering collaboration and longitudinal studies. Besides providing a thorough real-world test, we have optimized the procedure for application of the method to other species and developed protocols for grey wolf and Eurasian lynx. The method has a great potential not only for ecological research, but also for routine wildlife monitoring programs that require rapid, cost-effective genotyping of large numbers of samples.

Spatial targeting to achieve the dual biodiversity goals – ecosystem service provisioning and species conservation as such

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Biodiversity conservation must consider both the preservation of species as such and the maintenance of biodiversity for utilitarian reasons (ecosystem services), but it remains unclear if there are synergies or conflicts between strategies pursuing these targets. We used modelling to demonstrate that spatial targeting of conservation in agricultural landscapes could result in overall more effective conservation than uniform strategies, by pursuing species conservation (i.e. biodiversity at larger scales) in heterogeneous landscapes and focussing on ecosystem services in homogenous landscapes. In an empirical study, we applied this framework to existing EU strategies to conserve farmland plants and pollinators, specifically reduced farming intensity which primarily benefits ecosystem services, or increased farmland heterogeneity through preservation of semi-natural grasslands primarily crucial for conservation of species. A novel tool allowing upscaling of biodiversity consequences demonstrates that semi-natural grasslands may be a more cost-effective strategy for species conservation, but that organic farming is capable of maintaining ecosystem service providers (stable pollinator communities) throughout farmland. Given the infeasibility of creating new semi-natural grasslands, strategies focussing on grasslands may not be sufficient in already homogenous landscapes. Thus, preservation of semi-natural grasslands and reducing external inputs are complementary strategies for benefitting biodiversity and ecosystem services when spatially optimized.

Introduction of Reducing the future biodiversity crisis given different future words

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The Biodiversity Crisis in a Changing World requires acknowledging multiscale policy development and land-use planning. Global policy for future biodiversity conservation is ultimately implemented at landscape and local scales. Correspondingly, landscape-scale green infrastructure planning needs to account for future socio-economic dynamics at national and global scales. This includes deciding on the use of forests to mitigate climate change. Besides raw materials and biodiversity, forests provide multiple ecosystem services, including stress relief and reduction. However, holistic analyses of forests to meet the growing demand of wood and still retain multiple ecosystem services and biodiversity are still sparse. In the introduction of this symposium, I will present an approach to account for global Shared Socioeconomic Pathways (SSPs) or climate change mitigation, and the global demand for wood that they may bring with them, in projections of future woody and non-woody ecosystem services (ES), stress relief and reduction and multiple measures of biodiversity. Making reliable projections of biodiversity into the future requires models accurately reflecting interactions among species with different traits and acknowledging uncertainties. I will further introduce our approaches to account for these.

Mapping future mammal exposure to extreme drought and warm spells

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The frequency and intensity of extreme climate events such as hurricanes, floods and droughts are projected to increase over the next decades, significantly impacting global biodiversity. As endotherms,

mammals can maintain a high and constant body temperature, providing a high degree of thermal independence. However, exposure to extreme droughts and warm spells will potentially limit their capacity to thermoregulate, increasing their extinction risk. Therefore, identifying which mammal populations will be exposed to these events is essential to design proactive and effective conservation measures. Here, we derived global maps of future exposure of mammal populations to extreme droughts, warm spells, and both. We considered two different periods (2021 – 2040 and 2081 – 2100) and three greenhouse gas emission scenarios (RCP2.6, RCP4.5 and RCP8.5). To account for intraspecific differences in tolerance to extremes, we defined as a population the intersection of species' distributions and biomes. We identified as exposed the areas of the population that will experience drought and/or warm spell values substantially higher than those experienced during the historical period (1961 – 1990). We found that exposure to extreme droughts, warm spells, and both will increase with period and emission scenario.

Addressing human–tiger encounters using socio– ecological information on tolerance and risk

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Tigers are critically endangered due to deforestation and persecution. Yet in places, Sumatran tigers (*Panthera tigris sumatrae*) continue to coexist with people, offering insights for managing wildlife elsewhere. Here, we couple spatial models of encounter risk with information on tolerance from 2,386 Sumatrans to reveal drivers of human–tiger conflict. Risk of encountering tigers was greater around populated villages that neighbored forest or rivers connecting tiger habitat; geographic profiles refined these predictions to three core areas. People's tolerance for tigers was related to underlying attitudes, emotions, norms and spiritual beliefs. Combining this information into socio–ecological models yielded predictions of tolerance that were 32 times better than models based on social predictors alone. Pre-emptive intervention based on these socio–ecological predictions could have averted up to 51% of attacks on livestock and people, saving 15 tigers. Our work provides further evidence of the benefits of interdisciplinary research on conservation conflicts

Assessing People's Values of Nature: Where Is the Link to Sustainability Transformations?

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The efforts to measure people's current preferences and values of ecosystem services raise questions about the link to sustainability transformations. The importance of taking social and cultural values of nature into account is increasingly recognised within ecosystem services research and policy. This notion is informing the development of social valuation methods that seek to assess non-material social and cultural benefits of ecosystems in non-monetary terms. Here, 'values' refer to the products of descriptive scientific assessments of the links between human well-being and ecosystems. This use of the values term can be contrasted with normative modes of understanding values, as underlying beliefs and moral principles about what is good and right. While both perspectives on values are important for the biodiversity and ecosystem services agenda, values have mainly been understood in relation to assessments and descriptive modes. Failing to acknowledge the distinction between these modes bypasses the mismatch between people's current values and sustainability transformations. Refining methodologies to accurately describe social values risks simply giving us a more detailed account of what we already know—people in general do not value nature enough. Values studies should explore why or how peoples' mindsets might converge with sustainability goals, to incorporate change and transformation.

Movement models identify management targets overlooked by common space–use models: a case study of invasive wildlife in an agroecosystem

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The movements of individuals through space produce trajectories that, in aggregate, result in observed patterns of space use. Common approaches grounded in point–process models (e.g. Resource–Selection Functions, RSFs) are typically implemented to describe these patterns and to inform wildlife and landscape management. We contend that this can lead to failures in identifying critically important components of landscape structure and composition contributing to movement by and occurrence of wildlife species targeted for management, particularly when the processes of fine–scale movement and broad–scale space–use are determined by different factors (e.g. scale–dependent habitat functional responses). Here we discuss how such discrepancies can occur, why they are often linked to scale–dependencies, and how they can produce poor management decisions. We demonstrate the discrepancy in a case study of a critically invasive species (wild pigs, *Sus scrofa*) occupying a semi–natural agroecosystem. In particular, we show how the movement model approach identifies specific edge effects missed by the common RSF, and we identify important landscape management considerations grounded in the mechanisms driving pig movements to improve crop yields and minimize crop damage. Incorporation of movement explicitly into management–focused modeling efforts may thus provide new management targets that can improve long–term sustainability and viability of managed ecosystems.

Multi–taxon conservation strategies are highly needed, but also challenging: examples from boreal and hemi–boreal forests

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Setting–aside forest of high conservation value is a cornerstone in forest conservation strategies globally. The understanding of factors that determine high conservation value is, however, less well understood. Although it is widely acknowledged that the response to environmental changes varies greatly among species, such differences are rarely reflected in conservation strategies. Thus, we need a better understanding of factors determining conservation values, and how uniform of such factors are among different. Based on results from several studies, I here summarize how diversity of species of conservation concern varies depending on local and landscape factors in boreal and hemi–boreal forests in Sweden. The results show that local, landscape, and regional forest characteristics influence biodiversity in a non–uniform pattern among species groups and forest types. The environmental factors best explaining variation in species richness varies considerable among forest type (mixed forest, mixed coniferous forests, spruce–, and pine dominated forests) and among taxa (vascular plants, macro fungi, lichens and bryophytes), suggesting that there is no single conservation strategy that will preserve biodiversity across all forest types or across taxa. Nevertheless, the single most common measure associated with high species richness across taxa and forest types was amount of mature forest in the landscape.

A reduced SNP panel to identify wolf population admixture vs. hybridization with other *Canis* taxa

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Human-induced hybridization is a global threat to wildlife, and must be distinguished from natural intra- and interspecific gene flow. Genetic markers to differentiate among these processes are therefore essential for conservation. Genetically distinct populations of grey wolves (*Canis lupus*) are now reconnecting within Europe. However, the species is affected by hybridization with domestic dogs (*C. l. familiaris*), which are also known to hybridize with golden jackals (*C. aureus*) in south-eastern Europe. We used existing genomic resources to identify discriminant single nucleotide polymorphism (SNP) markers, with focus on the Iberian, Italian and Dinaric wolf populations, to (1) separate wolves, dogs, and golden jackals, and (2) identify their first two hybrid generations. We selected 192 SNPs that identified the five canid groups, all simulated first-generation (F1) hybrids ($0.482 \leq Q_i \leq 0.512$ between their respective parental groups) and all first backcross (BC1) individuals ($0.723 \leq Q_i \leq 0.827$ to parental groups). An assay design and test with invasive and non-invasive samples performed successfully for 178 SNPs, which correctly categorized the five groups and simulated hybrids. The identified SNPs permit differentiation between inter-specific hybridization and natural population admixture and promote data sharing among laboratories, facilitating evolutionary research, monitoring, and conservation of European canid populations.

Ecosystem based forest management in the city forest of Lübeck

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Since the early 1990 s, municipal forests in Lübeck, northern Germany, are not managed for pre-defined, specific forest structures or tree species compositions anymore. Instead, on 4,620 ha of forest area, Lübeck forest managers carefully accompany natural forest development and try to intervene as little as possible, avoiding disruption of ecosystem dynamics. Thereby, this approach differs from many silvicultural concepts that are also referred to as close-to-nature or natural. Research results from forest ecology and especially disturbance ecology had indeed been discussed for long, indicating that forest species richness requires a high continuity of forest history and developmental conditions, as well as unpredictable natural disturbances. Those ecological insights also challenged nature conservation planning specifications, in particular the protection of species and habitats. The presented management concept provides answers to these open questions. The Lübeck approach builds on regular monitoring (every 5–10 years, with sample plots and area-based inventories). Key indicators are: 1) standing volume in different forest ecosystems, including habitat trees and deadwood, compared to baseline areas, 2) degree of naturalness (tree species composition, incl. all successional stages, gap dynamics, horizontal and vertical vegetation structure), and 3) population parameters of species (mammals, birds, herbs, ferns and fungi).

National strategic planning and result-oriented CAP: a new obstacle or some good news for biodiversity policy integration?

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In the EU, the Common Agricultural Policy (CAP) is considered to be the critical public policy in terms of both impacts and funds dedicated to conservation. However, the goal of halting biodiversity loss in the EU remains elusive. By combining program theory and environmental policy integration frameworks, we assessed the current state of

strategic planning and mainstreaming of biodiversity into the CAP in a selected EU Member State. The policy's program logic model was found to be only loosely defined for most objectives. The key weaknesses were inadequate elaboration and quantification of needs and specific objectives, often unclear linkages to biodiversity policy legislation, and a lack of evaluations for particular measures. Furthermore, a significant gap was revealed between the relevance of measures, as declared in strategic documents, and their actual potential to achieve the stated objectives. Since decision-making is increasingly being devolved to the national level, the future CAP should thus include adequate safeguards and incentives to improve the quality of programming. In particular, the decision-makers should systematically close existing national data and knowledge gaps and strive to increase the capacity and motivation of national ministries to increase the CAP performance in the field of biodiversity conservation.

Carpathian Peatlands – functions, importance, conservation and improved management

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Peatlands are important ecosystems, providing valuable ecosystem services, e.g. acting as effective carbon sinks and water retention reservoirs. Mountain peatlands play a particularly important role: due to their location in the upper parts of catchments, they positively impact on water regimes over vast areas.

Peatlands are degraded by drainage, conversion into agricultural land, extraction of peat, fires, etc. Degraded peatlands are responsible for over 5% of the world's human-induced CO₂ emissions.

Meeting the goal of keeping the global average temperature rise below 2 °C compared to the pre-industrial era requires urgent action to keep the peatland carbon where it is – in saturated peat. We need to improve water conditions in already drained peatlands so that they can recover, ensuring sustained provision of ecosystem services.

We address this challenge with our new project „Carpathians Unite – Conservation of Orawsko-Nowotarskie Peatlands“, implemented in partnership with the Nature and Man Foundation and the Norwegian company Asplan Viak, with co-funding from EEA Grants. Its main objectives are active protection of valuable natural raised bog habitats, in the „Czerwone Bog Woodland“ reserve (Ramsar site), as well as the enhancement of wetland-friendly spatial management in the entire Natura 2000 „Orawsko-Nowotarskie Peatlands“ area.

Post-project use of ecosystem type, condition and services maps in conservation practice

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Ecosystem assessments provide valuable information on the extent and condition of ecosystems, and the range of functions and services they provide to society. However, both the methods and results of such assessments take time to find their way into conservation practice. We used an online survey to get some information about the post-project use of ecosystem type, condition and services maps in practice. Our first results are based on answers from six national or regional parks from six European countries who had carried out such assessments for their area. These show that ecosystem type maps are more widely used than ecosystem condition or services maps. Those who use any of the maps, use them regularly and for diverse tasks. The reasons for no use vary, in many cases there is simply no interest, but a post-project shift in the focus of the institution can also play a role. Data quality also features; the need for up-to-date maps based on field data (rather than just using available databases) was highlighted. While project participants tend to see the potential usefulness of such maps, there is still a lot to do to facilitate their use in conservation practice.

Combining local and academic knowledge to define and assess wild food plant sustainable foraging in Norway

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Wild food plants are well recognized as local sources of nutrition that can contribute to food security. In Europe, the use of wild food plants as an emerging trend in high-end gastronomy has raised concerns about the conservation of the foraged plant. Here, we co-designed a research project with the Norwegian Association for Mycology and Foraging to characterize and assess sustainable foraging in Norway. We conducted 19 face-to-face interviews and produced an online questionnaire. We enquired about what species are harvested, by whom and how, where do foragers learn, and what are their perspectives on the sustainability of foraging. Foragers base decisions on when and how much can be harvested on moral judgements considering location, plant, and plant part being harvested. They pay attention to plants' conservation status and local abundance, the plant individual's survival after foraging, and aim to not spread invasive species. We visualized their decision-making process as a flowchart that, combined with academically-produced data on ecological and social aspects of foraging, we use to assess sustainability of foraging in Norway. Finally, we propose ways to apply this co-created knowledge to support transmission of knowledge about low-impact practices and sustainability ethics in Norway and other geographical contexts.

A novel model applied on the constant effort mist-netting reveals important patterns in population dynamics of long-distance migratory birds

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Long-distance migratory birds are experiencing long-term population declines in Europe. Due to their complex annual cycle, there are two major classes of potential factors responsible for this decline. The cause might lie in the breeding grounds, where, for example, migrants' fecundity may be negatively affected by the trophic mismatch. Alternatively, it might be a result of changes in the non-breeding grounds that affect survival. Detailed study of the population dynamics, demographic parameters, and possible climatic drivers can help to reveal these causes in different species. We used capture-mark-recapture data from a constant effort sites (CES) mist-netting volunteer citizen science programme. These CES data provide good coverage for 16 species since 2004 at more than 50 sites in the Czech Republic. We developed a novel extension of the Pradel (1996) model which opens a new avenue to analyze CES data, allowing the decomposition of the population growth into survival and recruitment, facilitating the understanding of patterns in population dynamics. We also related the demographic parameters to the climate in the breeding (namely temperature, GDD5, and plant phenology) and non-breeding grounds (water availability) and compared their importance in different species.

Conservation biogeography of small Mediterranean islands

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Small islands represent a hotspot of plant diversity within the global diversity hotspot of the Mediterranean basin. These areas are particularly vulnerable to anthropogenic disturbance, species invasions, and the adverse effects of climate change. In this context, nano-hotspots (i.e., islands with higher species richness than expected simply

by area) can be identified and prioritized when planning conservation actions. In this study, we employed a large dataset of about 5000 vegetation plots located in 53 central Mediterranean small islands of different size, degree of isolation, morphology, geological origin, and climate. By drawing on classical biogeographic theory, we used the species-area relationship to identify alpha (plot-level) and gamma (island-level) hotspots of plant species richness. To assess the drivers underlying the observed patterns, we modeled species richness at the two spatial scales against a set of environmental and biogeographical predictors. Both alpha and gamma nano-hotspots are mainly located in southern Italian archipelagos, although with some discrepancies between the two spatial scales. After accounting for the area, gamma diversity is mainly explained by island morphology, while alpha diversity by island origin and local contingencies, with a marginal effect of climate in both. Our work explores the conservation implications of classical biogeographic theory across scales.

Bumble bee colony health and performance vary widely across the urban ecosystem

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Urbanisation can affect fitness and challenge the persistence of many species, including wild bees. Yet, how and which urban environmental features affect bee health and fitness remain unclear. Here, we placed experimental *Bombus terrestris* colonies in sites spanning from the edge into a city's core to investigate bee parasitism, foraging behaviour, energetic stress, colony growth and reproductive output. In each site, ambient temperature was recorded, floral resources were evaluated and landscape heterogeneity was characterized. We found that *Bombus terrestris* parasitism levels increased across the season in line with colony growth but was negatively related to the proportion of impervious surfaces. *Bombus terrestris* foraging trip duration decreased with increasing ecotones but increased in sites with honey bee hives present. Energetic stress increased with the proportion of impervious surfaces. Furthermore, high ambient temperature reduced colony growth and indirectly the production of gynes. Our results highlight the importance of ecotones as well as minimizing the intensity of urbanisation and urban honey bee beekeeping for bumblebee colony health and foraging behaviour. They also point to the importance of microclimate for bumblebee colony performance and suggest that increasing temperatures could have a negative impact in slowing colony weight gain, and indirectly in reducing colony reproduction.

With experimental approach towards sustainable forest management – upscaling local multi-taxon experiments to European level

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Exploring the impact of management on forest biodiversity is a crucial step towards developing sustainable management methods. Experimental approaches help to directly compare the effects of different forest manipulations including innovative strategies. In this project we mapped multi-taxon experiments in European forests, to build a network with the potential to upscale from local results to the continental level. We collected information on 28 experiments in 14 European countries covering a range of Mediterranean, temperate and boreal forest types. Beech and oak dominated forests were overrepresented among the experiments, while boreal, hemiboreal

and broadleaved evergreen forests were underrepresented. Most treatments involved tree cutting (thinning, gap-cutting, and clear-cutting) and/or microhabitat enrichment (deadwood and habitat tree creation). Other treatments were: game-exclosure, forest floor manipulation, prescribed burning, and water manipulation. Altogether 29 organism groups were studied in the network, with woody regeneration, vascular herbs, fungi, beetles, bryophytes, birds, and lichens being most commonly included, in descending frequency order. This allowed us an in-depth study exploring the influence of thinning and gap-cutting intensity on forest biodiversity. This presentation was supported by the BOTTOMS-UP COST Action CA18207 and TAČR Kappa ROTATE project no. TO01000132. FT was funded by the National Research, Development and Innovation Fund PD134302.

Policies impact on forest multifunctionality across Europe

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The provision of forest ecosystem services (FES) has long been considered as a side effect of traditional production-oriented forestry. However, increasing emphasis has then been placed in forest policies to deliver public goods such as biodiversity, recreation, and carbon sequestration, alongside timber production. Our is to, using multi-objective optimization, estimate the optimal management that maximizes multifunctionality (MF), and evaluate the losses in MF arising under different national policies in Nordic countries (Finland, Sweden and Norway) and Germany. To construct the scenarios, we used national forest inventory data that was projected into the future. For this, we estimated nine FES from nationally selected indicators. For each country, the multifunctionality of each sectoral policy scenario is calculated and compared with the maximum multifunctionality scenario. Our results show how the highest multifunctionality is achieved for Germany and Norway by the Forest Strategy and forest laws (for Sweden), but in Finland it is achieved by the Biodiversity strategy. In this way, we are able to evaluate the impact of each scenario on the multifunctional provision of FES and impact on biodiversity, depending on the types of forests, specific management and each country's strategy for forest policy implementation.

Timber demand effects on the multifunctional management of Non-Woody Forest Ecosystem Services and Biodiversity

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Future demand for timber products will affect forest management depending on the future climate and socioeconomic conditions and, it will, therefore, affect the capability of landscapes to provide forest ecosystems services and biodiversity (FESB). With the help of forest growth simulations, we show the performance of management regimes to provide FESB and the trade-offs between preservation of biodiversity, timber demands, and multifunctionality. We present a novel approach that, using Bayesian modelling, predicts the future provision of FESB. Moreover, using multi-objective optimisation, we

evaluate two scenarios that calculate the optimal combination of management regimes to fulfil the future demand of timber products and achieve landscape multifunctionality. In general, high proportions of harvest intensification would be needed to meet future timber demands, while continuous cover forestry contributes the best to multifunctionality. However, the distribution of diverse management regimes over the landscape offers the best solution in all optimised scenarios. Finally, we show how some FESB are more resilient (e.g. edible plants or bird diversity), while others are susceptible (e.g. mycorrhiza, temperature regulation or saprotrophic species) to management regimes. Thus, we will contribute to the biodiversity and multifunctional oriented management of landscapes accounting for future timber demands and with a measure of uncertainty.

Urbanization effects on insect pollinator diversity: a global meta-analysis

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Human population growth leads to globalization and an increase in urban areas. It is not clear how urbanization affects different insect pollinator groups. For instance, urban areas can be an ecological trap for pollinators because of habitat degradation (e.g. increase in concrete surface areas) and pollution. However, recent literature shows different various, even contradictory results, as urban environments can provide additional food resources, fewer predators, and further nesting places in buildings. We performed a meta-analysis to increase our understanding of urbanization effect on wild pollinators. We extracted 131 effect sizes from 58 studies for abundance and 114 effect sizes from 51 studies for species richness. We used pollinator taxonomical groups, urban-suburban-rural gradients, global urban heat island data, and river (as a natural element) presence as moderators. Pollinator abundance and species richness significantly decreased with increasing urbanization, a clear sign of biotic homogenization. Temperature difference (heat-island effect) between urban and suburban areas of more than 2 °C significantly amplified the negative effect of urbanization on pollinators diversity. Cities with rivers have a lower urbanization effect. For pollinator conservation in urban areas, there is a need to restore and maintain natural and green areas in cities, which can alleviate the heat island effect.

Plant biodiversity is highly resistant to shrub encroachment in loess steppe fragments

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We aimed to study the effect of native shrub encroachment on plant biodiversity in grassland fragments by analysing the vegetation composition of grasslands subjected to increasing levels of encroachment. Both ancient and spontaneously recovered grasslands were studied. We set the following research hypotheses: (i) increasing levels of encroachment decreases total diversity and the species richness of dry-grassland species; and (ii) the effect of woody cover on grassland biodiversity differs between ancient and restored grasslands. Altogether in 63 grassland fragments the percentage cover of trees, shrubs and herbaceous vegetation were recorded. Shrub encroachment affected the total richness of the herb layer and the species richness of dry-grassland species. For most of the studied variables, lowest values were found for the highest encroachment groups. Species richness of the herb layer and that of dry-grassland species were lower in restored grasslands. In recovered grasslands, Shannon diversity and species evenness were lower, while Berger-Parker dominance was higher than in ancient grasslands. Species composition and richness displayed a relatively high resistance to moderate shrub encroachment. Our results suggest that moderately encroached loess grasslands can be easily restored by the suppression of woody species, as their species pool still contains many dry-grassland species targeted for restoration.

Beyond organic farming – harnessing biodiversity-friendly landscapes

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We challenge the widespread appraisal that organic farming is the fundamental alternative to conventional farming for harnessing biodiversity in agricultural landscapes. Certification of organic production is largely restricted to banning synthetic agrochemicals, resulting in limited benefits for biodiversity but high yield losses despite ongoing intensification and specialisation. In contrast, successful agricultural measures to enhance biodiversity include diversifying cropland and reducing field size, which can multiply biodiversity while sustaining high yields in both conventional and organic systems. Achieving a landscape level mosaic of natural habitat patches and fine-grained cropland diversification in both conventional and organic agriculture is key for promoting large-scale biodiversity. This needs to be urgently acknowledged by policy makers for an agricultural paradigm shift. Tscharntke, T., Grass, I., Wanger, T.C., Westphal, C., Batáry, P., 2021. Beyond organic farming – harnessing biodiversity-friendly landscapes. *Trends in Ecology & Evolution* 2877. <https://doi.org/10.1016/j.tree.2021.06.010>

Ponui Island and promising potential for genetic rescue in a long-loved, flightless national icon

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One of the key challenges for biodiversity conservation is how to manage species with severely fragmented distributions. Translocations are an important tool in these scenarios to increase the number of individuals, and increasingly to deliberately boost genetic diversity and thus population growth rate, a phenomenon known as genetic rescue. However, uncertainty around such rescue remains. Here I present results from the North Island brown kiwi (*Apteryx mantelli*) population on Ponui Island. Thanks to a dual origin translocation in 1964, and close monitoring since 2004, we have recently been able to show that 1) this is one of the densest *A. mantelli* populations within the range, 2) birds from the two source populations interbreed, 3) some birds breed in groups of more than two unrelated individuals, and 4) this population is more genetically diverse than populations with either a single translocation origin, or no translocation history. Together this suggests a high potential for genetic rescue in this national icon; importantly if genetic rescue is possible in a group like kiwi (which are extraordinarily long-lived, show high pair fidelity, and do not fly), this is eluding to a greatly understudied and underutilised potential for genetic rescue in many other threatened taxa.

Differences in assessment of relative importance of certain ecosystem services amongst stakeholders linked with a Central Hungarian forest

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The OKAEYLIFE LIFE-Nature project targets the conservation of key habitats/species and the restoration of key ecosystem services (ES) in Peszér-forest, Central Hungary. Representatives of the main stakeholders (state forestry company, national park directorate, nature conservation NGO, local municipality, local hunting association, in total 17 persons) were involved in face-to-face interviews and in a two-round online questionnaire survey to identify differences in declared relative importance of certain ESs. Stakeholders were asked to explain why the forest is valuable and what it provides to local inhabitants/whole society (an indirect way to name ESs which they consider the most valuable). These ESs were grouped following the MAES protocol, and then stakeholders were asked to add other ESs they were aware of. Finally, the stakeholders were asked to rate the relative importance of all ESs listed. Analysing the rate scores, we could identify ESs not known by certain stakeholders (e.g. possibilities for scientific research); mutually highly rated ESs (e.g. climate regulating

ESs); conflicting ESs (e.g. hunting possibilities vs. forest resilience/natural regeneration); differently rated but not conflicting ESs (e.g. recreation). Via identifying not conflicting ESs, modifications have been applied in forest management that can lead to more efficient conservation/restoration of ESs provided by the forest.

Can global biodiversity trends be detected using local species richness?

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Quantifying biodiversity trends at the global scale remains largely unresolved. This is because global analysis of biodiversity change is typically based on a collection of locally monitored sites which are affected by certain sampling biases and measurement errors. Here, we assess the ability to detect global trends using local species richness and the effect of time series length, site-selection biases, measurement error, and taxa mobility (represented by spatial resolution). We find that even with error-free data thousands of sites are needed for decadal times series and detecting trends within a year was practically impossible. Measurement errors in local species richness trends drastically reduced the ability to detect a change, with ten times more sampling sites required with up to 5% measurement error. The ability to detect change was lower at higher resolution. Additionally, spatial sampling biases, such as failing to sample areas in the top 1% of largest losses will not only reduce the ability to detect negative change but can even result in a positive trend. We conclude that detecting global trends using estimates from locally monitored sites is currently unreliable, and requires implementing refined observation networks combined with models to account for biases, measurement error, and environmental drivers.

Eurasian crane (*Grus grus*) as ecosystem engineer in grasslands – conservation values, ecosystem services and disservices related to a large iconic bird

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Large birds, such as cranes are involved in human-wildlife conflicts as they often forage in croplands. The Eurasian crane (*Grus grus*) is a large iconic bird species, protected across Europe, which, thanks to conservation programs and its ability to utilize croplands for foraging, shows a strongly increasing population trend. This exaggerates the already existing conflicts between farmers and cranes spilling over to natural habitats, where foraging by large flocks can lead to land degradation. Here we evaluated the effect of biopedturbation by cranes on the vegetation of dry grasslands in Hungary. We used indicators of vegetation naturalness, forage quality and floral resource provision to evaluate the ecosystem state from multiple aspects. We sampled 100 quadrats in disturbed patches and 100 in intact grasslands in two seasons and two years (800 observations). We found that cranes created distinct early-successional habitat patches characterised by increased the plant diversity and floral resources compared to intact grasslands. Although crane-disturbed patches could provide forage for livestock early in the season, the forage quality became poor later in the year. Given the increase of the global crane population, monitoring the disturbed areas, and developing a complex prevention and mitigation strategy is important.

Comparing interest in nature across culturomic and other digital sources

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Conservation culturomic enables the exploration of human-nature interactions and cultural ecosystem services at scales unimaginable until recently. Nonetheless, these tools and datasets entail inherent biases and necessitate careful validation. Here, we analyzed various digital data to construct a framework linking digital sources with species' cultural ecosystem services. We explored interactions with wildflowers in Israel across different culturomic sources including social media, search engines, online encyclopedias, and popular media articles, as well as large online scientific databases, and citizen science platforms. These sources represent different types of engagement with nature, by different segments of society. We found that different platforms highlight different species and traits with most discrepancies between popular news media and a national scientific repository. Furthermore, salience in Flickr, a social media platform often used for cultural ecosystem services analysis, does not correlate with any other source. Our results suggest that people's digital interactions with nature may be inherently different across sources and platforms. Thus, analyzing multiple digital sources may allow better understanding of the wealth, span, and value of different human-nature interactions across the digital realm.

How supportive can deep learning be in biodiversity research? Three tales of cultural services, biological invasions, and wildlife trade

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The global spread of the internet has spurred the emergence of new conservation approaches focused on the comprehension of biodiversity patterns as well as on the interlinkages between people and their environment. People increasingly create imagery and textual content on the web, either through the search for topics of interest, the expression of opinions about newsworthy events, or the uploading of photographs and videos in social media platforms. As such, internet users passively offer huge amounts of data which can be used to get real-time insights into a multitude of issues pertaining to ecology and conservation. Inevitably, dealing with the massive amount of social media data produced by an increasingly number of internet users, becomes a major technical (and ethical) challenge to extract meaningful information for conservation. The recent technological advances from artificial intelligence algorithms, and specifically from deep learning, have empowered social media analytics to become prominent in conversation research. This talk will present recent advancements associated to three case studies using deep learning tools over social media imagery data to: (1) identify opportunities for cultural ecosystem services, (2) detect invasive alien species and its distribution, and (3) identify protected species prone to wildlife traffic.

Urban grassland habitats are valuable for maintaining insect and plant diversity

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Grasslands are the primary habitat of numerous threatened plant and insect species. As elements of urban green infrastructure, grasslands have a high potential for supporting biodiversity in urban regions. The city of Helsinki has a network of diverse grassland habitats, some of which are managed primarily for biodiversity. I investigated the assemblages of vascular plant and selected insect taxa, of a set of approximately 20 grassland sites in the Helsinki capital region. The aim of this study is to determine the potential value of a set of urban grassland habitats for supporting insect and plant diversity. I also

investigate what environmental factors determine the suitability of these sites for different taxa. All of the taxa showed species-area effects, indicating that the small size and isolation of sites are a major challenge. The carabid assemblage is diverse and varies with habitat type, indicating that habitat diversity determines carabid diversity. The bee assemblage is diverse, though dominated by polylectic and ground-nesting species. The butterfly assemblage is poor and included only one meadow species. I conclude that grasslands are valuable for the conservation of urban plant and insect biodiversity but measures should be implemented to enhance habitat provision and reduce habitat isolation.

Conservation planning in a context of land use change and multiple sustainability targets

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Conservation planning is often based on the current land use situation. However, land use is dynamic, either putting future constraints on conservation through increasing pressures, or bringing new opportunities, e.g., due to agricultural land abandonment. Such pressures and opportunities also arise through efforts to achieve other sustainability targets at the same time, which might be conflicting or synergistic. Integrated land use planning at different spatial scales is required to align the different demands on space and find more optimal solutions and/or make the tradeoffs explicit. However, the methods and tools available to support such integrated spatial planning processes are still limited. In this presentation I will provide a number of approaches that go beyond conservation planning alone, accounting for land use change dynamics and multiple claims on land resources. The approaches can be oriented more top-down or more bottom-up, leading to different solutions for the same region. Scenario simulation of the implications of such solutions helps discussing future land use and the barriers towards implementation.

(In)Coherences of national forest policies in Europe; examples from Norway, Finland and Germany

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To mitigate the negative effect of climate change, the European Union aims to achieve a sustainable and climate-neutral bioeconomy. This bioeconomy scenario implies increasing the use of wood to replace GHG-intensive material, which may conflict with other forest policies domains, such as the EU biodiversity strategy or National sectoral policies, which represent diverse interests. These incoherencies will have a long-term impact on forest ecosystem services (FES) and biodiversity conservation. Here, we investigated how consistent are these forests policies and what are the effect on the provision of FES. We used national forest inventory plots from Finland, Norway, and Germany to simulate 100 years of forest development using different combinations of management regimes. Then, we defined three different forest policy scenarios, according to the most relevant policy, national forest policy (NFS), biodiversity (BDS), or bioeconomy (BES). We used multi-objective optimization to identify the combination of management regimes matching best with each policy scenario. We found that in Finland a Germany, the NFS was the most detailed document, while in Norway, the BES was the most comprehensive one. Here (Norway) we also observed that the BDS scenario might not be realistic, since it implies not including any objective related to harvest.

Naturalistic grazing by large herbivores in a wetland non-governmental Bird Reserve Josefov Meadows, Czech Republic

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The Bird Reserve Josefov Meadows is the unique project of the Czech Society for Ornithology, partner of BirdLife International. It has been established on land purchased with the support of many donors – organizations and the general public (mainly members and fans of the Czech Society for Ornithology). The conservation project, implemented on the outskirts of the town of Jaroměř in Eastern Bohemia, is based on the restoration of a historic artificial irrigation system. Management measures include simulation of natural flood regime by water level control, excavation of shallow pools and patches of exposed substrate, shrub encroachment control, grazing by large herbivores and/or mowing. The wide array of methods provides a suitable environment for the most endangered birds in Czechia – the meadow waders, rails and crakes and other birds requiring wet meadows. During the first five years after introduction of large herbivores, positive response has been documented in 7 out of 10 priority species, all of conservation significance, i.e. snipe, redshank or spotted crane.

Biodiversa+, the new European-funded biodiversity partnership

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Gathering 74 research programmers and funders and environmental policy actors from 36 European and associated countries, Biodiversa+ works on five interconnected objectives: plan and support research and innovation on biodiversity; set up a network of harmonised schemes to improve monitoring of biodiversity, building on existing national/regional schemes and the work of EuropaBON (i.e. testing/operationalizing relevant outcomes in different contexts and countries); contribute to deploying Nature-based Solutions and valuation of biodiversity in the private sector; ensure efficient science-based support for policy-making; and strengthen the relevance and impact of pan-European research on biodiversity in a global context. Biodiversa+ allocates 1/3 of over 800 M€ budget for biodiversity monitoring. The work on this theme aims at three main outputs: i) establishment of transnational network of harmonized biodiversity monitoring schemes across Europe; ii) promotion and use of new tools and approaches for biodiversity monitoring; iii) support and enhance of biodiversity monitoring schemes better articulation with R&I and policy. The ultimate goal of Biodiversa+ regarding monitoring activities is to improve monitoring of biodiversity and ecosystem services and to provide better knowledge on their status and trends.

NaturaConnect – Designing a resilient and coherent Trans-European Network for Nature and People

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The EU 2030 Biodiversity Strategy aims to put biodiversity on the path to recovery by 2030, as a contribution to the European Green Deal goal of preserving and restoring Europe's natural capital. A key component of the EU Biodiversity Strategy is the development of a truly coherent Trans-European Nature Network (TEN-N). While the Commission has produced criteria and guidance for protected areas designations for its 2030 protected area goals, there is no operational framework to ensure these designations are spatially connected and complementary to each other both at pan-European, national

and sub-national level. To address these challenges, the NaturaConnect project aims to co-create with key decision-makers and other key stakeholders, knowledge, tools and capacity building to support Member States in realizing an ecologically representative, resilient and well-connected network of conserved areas that contribute to achieving the objectives of the EU Biodiversity Strategy to 2030. In this presentation we will introduce the project, its approaches for assessing the sufficiency of the network and how to address gaps in TEN-N, and the 6 project case studies, where we expect direct implementation of the project findings. Finally, we will present how the wider conservation community can engage with, and benefit from the project.

Impact of tracking devices on health and animal welfare in Northern Bald Ibis

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A migratory population of Northern Bald Ibises (*Geronticus eremita*) is currently reintroduced in Europe, in the course of a LIFE+ project (LIFE NBI). GPS-tracking of the whole population is essential for overall monitoring and management. Since 2016, we observed more than 30 birds with an opacity of the cornea in one eye, with varying intensity up to blindness. While this condition could not be linked to infections, we found a strong correlation between one-eye opacity and the use of solar powered GPS-devices fitted on the upper back of the birds. We also found that birds with mild opacity recovered fast after we removed their tags or changed the tag position to the lower back. Since birds sleep with the head on the back and one eye placed close to the device, the most parsimonious explanation for the symptomatic is a permanent slight irritation of one eye during resting and sleeping. The position of the devices on the upper back is also disadvantageous from an aerodynamic perspective and released birds equipped with such devices show reduced flight performance. We conclude that the decision how to fit the tracking devices on the animals can impact the health and welfare of the birds.

Sustainable human-megafauna coexistence potential and the role of willingness to coexist

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We have to look beyond mere tolerance or survival of megafauna and humans to assess if they can sustainably co-exist in an area. To be able to assess sustainable coexistence potential, we thus need integration of social and ecological perspectives, and inclusion of people's willingness to coexist with megafauna. As an interdisciplinary, international network working in elephant and rhino conservation, we therefore apply Bayesian hierarchical occupancy modelling to detect people's willingness to coexist with megafauna. We present our framework of sustainable human-wildlife coexistence potential, and the results of several applications of our willingness to coexist measure. We highlight the potential of combining this willingness to coexist measure with Species Distribution Models, using 556 interviews with Masaai people across the Maasai Mara, Kenya, collected January-March 2020, remote sensing data and aerial surveys. We also show its possibility to track changes in willingness to coexist with a second dataset of 280 interviews collected April-May 2021. Our framework, and measurement of willingness to coexist are useful in the field of Human Wildlife Conflict and Coexistence, as the measurement appears realistic enough to represent people's support for living with megafauna, and reliable as quantitative component to be included in existing habitat suitability assessments.

European Breeding Bird Atlases as a tool to study large-scale changes in biodiversity

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The first European Breeding Bird Atlas (EBBA1) was published in 1997 and the second one (EBBA2) in 2020. Both atlases are based on fieldwork of skilled volunteers and professionals and document the breeding occurrence and abundance for the whole of the European continent in a standardised 50-km grid. They provide information on the status and abundance of each species in each grid square in categories of breeding codes and abundance. In addition, EBBA2 provides modelled maps of the probability of occurrence at a resolution of 10x10 km. EBBA1 and EBBA2 allow to compare the distribution of species and assess changes over the last 30 years. 35% of all native species have increased the area where they breed since the 1980 s, 25% have contracted their breeding range and the rest did not show a change or the trend is unknown. While the breeding ranges of species moved on average to the north, there are range shifts in other directions too. The observed range shifts are not always consistent with results from predictive models using information on climate and land use. Thus, real data on species distribution changes is needed as a basis for research and conservation and particularly to validate models.

The role of the Ramsar Convention on Wetlands in conservation – a review of wetland policy and practice

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The Convention on Wetlands is an international legal treaty signed by 172 countries with the mission to conserve and wisely use all wetlands through local and national actions and international cooperation. It brings together scientists with policymakers and offers tools for various topics, e.g. floodplain and peatland restoration or wetland management. Worldwide, a network of over 2,400 wetlands of international importance has been established. The first Global Wetlands Outlook, published in 2018, provided the opportunity to promote our increased understanding of wetlands, while reporting on their status, trends and pressures. Findings, such as the fact that 25% of over 19,500 wetland-dependent species are threatened with extinction, constituted a global wake-up call. For the Convention's 50th anniversary in 2021, the Global Wetlands Outlook Special Edition was prepared. It draws on more than 30 major global and regional assessments and other recent scientific findings, and underlines the importance of wetlands for human health in light of the COVID-19 pandemic. Failure to meet the Aichi Targets and slow progress on the Sustainable Development Goals show that new approaches are needed. Researchers are encouraged to engage actively with the experts of the Ramsar Scientific and Technical Review Panel at national, regional and international levels.

What urban ecology can learn from agroecology and biodiversity research

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Urban ecology is a relatively young field of research, as biologists have long ignored the city as a proper habitat that is worthwhile to study. Much of current urban ecology research is still descriptive and focusses on explaining what species occur within the city, and on the conditions that allow plants and animals to live within the urban environment. Urbanisation is a form of human land use and different places within the city differ in land use intensity. As a result of these differences in land use intensity, different places within the city differ in species richness and composition. I propose that urban environments do not fundamentally differ from other habitats modified by humans, hence urban ecology can benefit from the progress made by research on land use effects on biodiversity and ecosystem functioning in these other habitats. I give examples where urban ecology

can learn from the progress that has been made by agro-ecology and functional biodiversity research, with respect to a) how land use effects on biodiversity can be investigated, b) what biodiversity-ecosystem functioning relationships may be expected, and c) ways to find more sustainable land use strategies. Conversely, with its focus on extreme cases of human land use, urban ecology can also contribute to a better understanding of land use- biodiversity -ecosystem functioning relationships in other habitats.

Integrating biodiversity into productive arable agricultural systems

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Intensively managed arable farming systems are by necessity run as commercial enterprises and farmers remain focused on both profitability and efficiency with the maintenance of biodiversity typically being something that needs to fit around these concerns. However, the large area covered by these systems provide significant scope for altering practices to support biodiversity by altering the character of these management practices across a range of spatial scales. For farmers perspective it is the provision of ecosystem services, like pollination and natural pest control, that may be of greatest interest as it represents an intersection between biodiversity and agricultural productivity. In this talk we will look at the potential and limitation for modern intensive arable farming systems to be softened to support improved biodiversity and ecosystem service provision provided largely by invertebrate communities. We will look at the extent to which field scale yields can be supported by such biodiversity mediated ecosystem processes and consider the problems associated with driving change in the farming community where harsh economic decisions can limit shifts to more sustainable practices.

Moving towards sustainable agriculture through transformational conflict science

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Agriculture provides essential goods and services supporting human wellbeing, but in a changing world there is a need to transition to sustainable food production systems, as highlighted in recent assessments such as IPBES, and policies including the CAP. This process, however, creates conflicts between actors with different views on how best to achieve such a transition. Reframing the agricultural crisis as a conflict offers the potential for achieving innovative and sustainable solutions, implying fundamental changes in 1) individual perceptions of the conflict, 2) the approaches used to mitigate conflict, and 3) the relationship between people in conflict. We present a novel transformation framework applied to conflicts in agricultural contexts before outlining results from three French case studies (around apiculture, viticulture and water quality), where conflicts exist over the reduction of pesticides. Qualitative interviews from these case studies outline a range of conflicts and how conflict and crisis across these case studies can act as positive tipping points for transformation towards more sustainable agriculture.

The role of Sacred Natural Sites in Italy for conserving biodiversity, forests and cultural landscapes

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Sacred Natural Sites (SNS) have demonstrated their capacity to conserve species and habitats, while being almost ubiquitous. However, most of research has been focusing in tropical areas, neglecting a large portion of SNS and related biodiversity. Here I present some results of an Italy focused project, focusing on different facets of biodiversity and land conservation. First, we created one of the first-ever georeferenced nation-wide survey of SNS and compared SNS distribution with Protected Areas distribution in terms of landscape and land use characteristics. Second, we analysed SNS and Protected areas in respect with forest loss and forest gain. Third, we selected 30

SNS across Italy and sampled plant diversity therein and in control areas to evaluate their contribution to plant diversity conservation. SNS showed a small overlap with Protected Areas, being found in cultural landscapes often undergoing land abandonment. We also found that SNS were associated with increased forest gain and decreased forest loss. Finally, SNS showed slightly higher biodiversity values than control areas, with patterns varying across habitats. Results underlie the need for a legal recognition of SNS and innovative policies to help conserve their cultural and natural values.

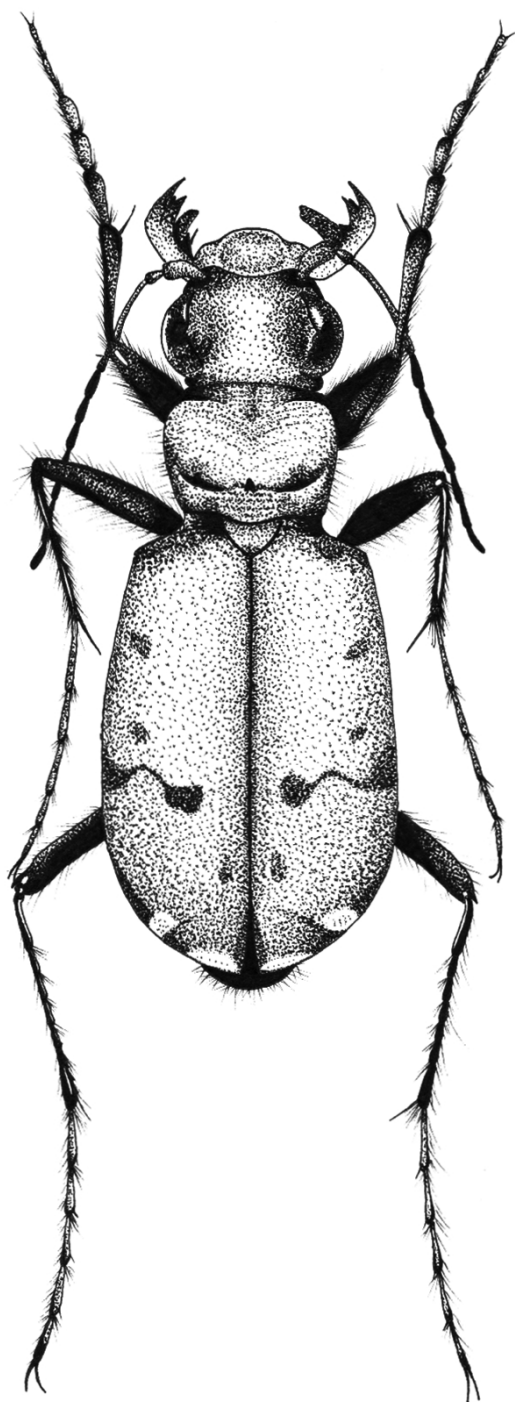
Meeting both conservation and animal welfare goals in wildlife research

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Wildlife research remains crucial for increasing our knowledge and improving species management and conservation amid the current biodiversity crisis. However, obtaining information on population status often involves the invasive or lethal sampling of a certain number of individual animals. Marking and sampling practices include taking blood and tissue samples, toe-clipping of amphibians and rodents, or using implants and radio transmitters – all of which are techniques that might negatively affect the animal. Wildlife research may then result in a fundamental conflict between individual animal welfare and the welfare of the population or ecosystem that would be achieved through conservation. This conflict could be significantly reduced if non-invasive and non-lethal research practices were more broadly applied. In this talk, I will provide an overview of the most common research practices and discuss the potential animal welfare issues associated with them. I will then outline guidelines on available non-invasive research alternatives, which can contribute to both improved data collection and minimized impact on animal welfare. I will also discuss the role of animal welfare science and the 3Rs principles for animal use (Replace, Reduce, Refine) in guiding responsible research in conservation biology.

Abstracts of oral presentations



Graphics by: Sarah Maršíková
Cicindela campestris Linnaeus

Using presence-only points to model the influence of climate on the broad-toothed rat (*Mastacomys fuscus*)

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Climate change is a major threat to small mammals in cold wet environments, particularly in alpine areas. The broad-toothed rat (BTR) (*Mastacomys fuscus*) is a small mammal found in alpine and sub-alpine areas of south-east Australia. We used a Point Process Model (PPM) to determine the impact of climate on the BTR using data from biodiversity atlas schemes. These atlases are often unreliable, so data cleaning is important. To determine the optimal data cleaning method, we employed three different methods, each of which produced a dataset that we used to run a separate PPM. In the first, we simply removed duplicates ($n = 1455$). In the second, we removed records that had a moderate chance of being unreliable ($n = 1062$). In the third, we removed records that had any chance of being unreliable ($n = 574$). The best fitting model, based on AIC and IMSE, was that conducted with the third dataset. Altitude, precipitation and temperature all had a significant impact on the BTR. This research exemplifies how species distribution modelling can be used to enhance our understanding of a species' climatic niche.

Impact assessment study of wind energy infrastructure spatial planning on large birds of prey of Greece– Sensitivity mapping methodological approach

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The installation and operation of Wind Power Plants (WPP) has been proven to have negative effects on biodiversity, especially on birdlife. In the present work, we studied the interaction of WPP development in Greece with nine large birds of prey that are particularly vulnerable to collision and displacement due to wind energy infrastructure. Specifically, we examined the spatial overlap of existing and planned WPP with the reproductive distribution of these species and we produced sensitivity maps. Overall, we found that 1027 (37.9%) of the existing wind turbines are located in a distance of less than 5 km from known breeding sites, while in the hypothetical scenario of implementing all planned projects, 6070 (36.7%) wind turbines will be located at a distance less than 5 km from 62.9% of all the species breeding sites included in this study. The breeding distribution of *Gyps fulvus*, *Gypaetus barbatus* and *Aquila chrysaetos* exhibit the greatest potential overlap with WPP (i.e., 82.9%, 75% and 61.1% respectively). We conclude that the development of wind energy in Greece can be extremely detrimental to the conservation status of the study species, if appropriate spatial planning measures are not applied.

The White-backed Woodpecker as an umbrella species for threatened saproxylic beetles in Central Europe.

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The umbrella species concept postulates that conservation schemes

targeting a key species, although often locally restricted, will simultaneously benefit additional organisms of conservation concern. The White-backed Woodpecker is an old-growth deciduous forest specialist and has been proposed as an umbrella species for saproxylic beetles in Scandinavia and Eastern Europe. Yet, whether this link holds in Central Europe remains unclear. By combining White-backed Woodpecker telemetry data with flight interception traps for insects, we compared saproxylic beetle communities at sites with no, low and high activity of the target bird species during its breeding season. We found that species richness of threatened saproxylic beetles paralleled the activity density of the woodpecker, with the highest richness found in high activity sites. Further, a multivariate analysis of community revealed that sites occupied by White-backed Woodpeckers harbored a consistent subset of the threatened saproxylic beetle community. This finding was corroborated by an indicator species analysis, showing that several threatened saproxylic beetles were associated to the woodpecker habitat. Overall, our results imply that the White-backed Woodpecker is a suitable umbrella species for the conservation of saproxylic beetles in beech dominated forests of Central Europe, supporting geographic transferability of the umbrella species concept in this study system.

Citizen science outperform standardized Atlases as data source when predicting narrow-ranged species

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While data combinations from different sources proved to be a useful tool in species distribution models (SDMs), there is still much to explore on the usefulness and/or uncertainty of each input data source through the modelling process. We assessed the effects of uncertainty in SDMs using different data sources in both response (citizen-collected and standardized datasets) and predictor (macroclimate and remotely sensed) variables on SDM performance across a wide range of bird species (236) with contrasting distributional ranges in the Iberian Peninsula. We implemented a SDM ensemble-forecasting approach by using the occurrences of bird species grouped in four range size classes from the semi-structured eBird project and standardized Atlases, and by using three predictor types: climate, remotely sensed ecosystem functional attributes (EFAs), and their combination. Based on generalized linear mixed-effects model results, data source, size class and predictor showed significant effects on SDM performance. eBird-based models outperformed those built with Atlas data for less widespread (rare) species, and the combined climate-EFA predictors yielded models with the best performance. Our findings confirmed that less widespread species with clear conservation concerns benefited from the inclusion of citizen science data and other key environmental factors into SDMs, with strong implications for species conservation.

Amphibians and reduced impact logging: variable species but similar community responses

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Although sustainable forestry methods such as Reduced Impact Logging (RIL) may mitigate severe biodiversity declines, RIL's direct/indirect impacts are poorly understood, particularly in taxa utilizing multiple habitats, i.e. amphibians. To determine amphibian responses to RIL and its direct/indirect impacts, we assessed amphibians in stream and terrestrial habitats before/immediately after logging (<1 year) in Malaysian Borneo. We used multi-species community occupancy models, to determine species and community responses to direct/indirect RIL effects, followed by diversity profiles to identify shifts in post-RIL diversity. Indirect logging impacts (distance to logging roads), proved a better predictor of stream amphibian occupancy, whereas direct logging impacts (leaf litter depth shifts), were more

associated with terrestrial species. Communities across habitats generally exhibited increased diversity metrics after logging compared to control sites. These increases are likely due to temporary fluxes and/or delayed RIL impacts, as we previously identified a decline in stream amphibian diversity 4–5 years post-RIL, followed by a swift recovery over 20 years as habitats and amphibians returned toward pre-logging states. These findings, not only suggest that amphibian communities respond similarly to RIL despite species level variation in direct/indirect RIL impacts, but also supports the use of RIL for amphibian conservation within tropical timber concessions.

Why Do UNESCO Biosphere Reserves Get Less Recognition than National Parks? A Landscape Research Perspective on Protected Area Narratives in Germany

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This presentation explores how landscape research can contribute to our understanding of why integrated protected area concepts like biosphere reserves get less recognition than national parks. In this regard, we analysed policy documents and online communication of biosphere reserves and national parks, conducted qualitative interviews with conservation professionals and volunteers as well as participant observation in order to identify and compare narratives that guide the communication and perception of both protected area categories. The results show how national parks offer a clear interpretation of space by building on landscape stereotypes and creating landscape legibility and experience-ability through touristification. National Parks also experience conflicts about proper management and combine a variety of goals, often including regional development. Nevertheless, their narrative is unambiguous and powerful. Biosphere reserves, on the other hand, have an image problem that is essentially due to the difficulty of communicating their objectives. They confront the difficult task of creating a vision that combines development and conservation while integrating contrarious landscape stereotypes. We argue for a fundamental engagement with protected area narratives, as this improves understanding of protected areas' transformative potential.

Spatial ecology of conflicts: unravelling patterns of wildlife damage at multiple scales

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Human encroachment into natural habitats is typically followed by conflicts derived from wildlife damage to agriculture and livestock. Spatial risk modelling is a useful tool to gain an understanding of wildlife damage and mitigate conflicts. Although resource selection is a hierarchical process operating at multiple scales, risk models usually fail to address more than one scale, which can result in the misidentification of the underlying processes. Here, we addressed the multi-scale nature of wildlife damage occurrence by considering ecological and management correlates interacting from household to landscape scales. We studied brown bear (*Ursus arctos*) damage to apiaries in the North-eastern Carpathians as our model system. Using generalized additive models, we found that brown bears' tendency to avoid humans and the habitat preferences of bears and beekeepers determine the risk of bear damage at multiple scales. Damage risk at fine scales increased when the broad landscape context also favoured damage. Furthermore, integrated-scale risk maps resulted in more accurate predictions than single-scale models. Our results suggest that principles of resource selection by animals can be used to understand the occurrence of damage and help mitigate conflicts in a proactive and preventive manner.

Persisting lineages in introduced species

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To understand colonization success of an invasive species we need to know the origin of the founders, where and when they were introduced, and spread from introduction site(s). Admixture of different genetic lineages from multiple introductions is generally hypothesized to be beneficial thanks to adaptive variation and heterozygosity-fitness correlations. In this study, population genetic and landscape data was gathered for Roesel's bush-cricket currently expanding its range in Europe. We examined how colonization history and landscape structure affect its spread and population genetic structure. Using ecological and dispersal information with genetic structure inferred from 29 locations, we found that two parapatric founding lineages coexist with very little gene flow. Our findings are in strong contrast to the hypothesis that different genetic lineages will admix when introduced to the same area. The presence of separate lineages decades after introduction and without physical barriers shows some mechanism prevents admixture. Lineages with different genetic setups may have adapted independently to local conditions and their admixture result in loss of locally adapted genotypes and less viable hybrids. Our data indicate that human transportation of agricultural goods may play an important role for the spatial genetic pattern of the species by aiding the spread.

The Importance of Green Infrastructure for Deadwood Dependent Beetles

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Deadwood dependent species account for a dominant proportion of forest dwelling organisms and substantially contribute to forest ecosystem functioning. Due to environmental changes induced by modern forestry, many of these species are today threatened with extinction. To halt this negative trend, the Swedish state owned forestry company Sveaskog, has established large forest areas throughout the country, so called Ecoparks, which serve as multifunctional landscapes aiming to combine forestry and nature conservation on a landscape level. Throughout the years, many restoration measures have been carried out in the Ecoparks in order to increase the habitat quality for forest dwelling species. To study the effects of multifunctional landscapes, we monitored saproxylic beetles for three consecutive years in two Ecoparks, one in southern Sweden, one in the north, and two reference areas representing business as usual (BAU) landscapes. We found that both Ecoparks sustained greater abundance and richness of nationally red-listed beetles and contained different beetle assemblages in comparison with BAU areas. Our results highlight the potential of multifunctional forests in conserving biodiversity of saproxylic beetle species. It also shows of the importance of deadwood availability as well as the importance of landscape configuration.

Behavioural ecology of reintroduced Przewalski's horses in the Great Gobi B Strictly Protected Area (Mongolia). Implications for conservation.

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Reintroduction is one of the most effective conservation techniques, but the risk of failure is high since the animals must adapt to a harsh novel environment. Przewalski's horse, once listed as Extinct in the Wild, is one of the best examples of successful reintroduction since

1992 (Gobi B). The current population, around 350 individuals, involves wild-born, long-term and newly reintroduced individuals. By direct observation of selected harems, we studied the effect of the origin (wild-born vs reintroduced) on the response to environmental conditions, social network and habitat use at harem and individual levels. Significant influence of the origin was found for all these categories. Compared to long-term reintroduced harems/individuals, wild-born groups showed clearer ethograms, well adapted to the changing weather conditions, complex social networks, and selection of habitats with higher NDVI values. Newly reintroduced groups (during soft release) showed the less complex patterns. The results confirm a slow behavioural adaptation of the horses to a new environment, probably not total until the second generation comes. These results may assist future reintroduction programs and the successful conservation of the species. Future research may focus on captive breeding conditions and their effects on subsequent adaptation to reintroduction at the individual level.

Effects of sown wildflower fields and strips on wild pollinators in agricultural landscapes

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In pollination, which is one of the most important ecosystem services, the wild pollinator insects play an invaluable role beside the managed honey bees. Agricultural landscapes can suffer greatly from the lack of these useful insects that can be enhanced in their number and diversity by providing floral resources such as flowering strips or fields. However, we do not know the optimal design and floral composition of these flowering fields in landscapes with different levels of heterogeneity yet.

Therefore, we set up sown wildflower parcels of different designs: 8 landscape pairs of one larger field (half hectare) and three smaller strips (total: half-hectare), sown with 32 native plant species, in either homogeneous (4 pairs) or heterogeneous (4 pairs) agricultural landscapes. We investigated their effects on wild pollinator insect communities by transect sampling method supported by assessment of flower resources.

Based on our results we expect to answer how diversity of flowering plant species, heterogeneity of the surrounding area and design of the flowering fields affect pollinator diversity, species richness and abundance, and we can determine which flowering plant species play a key role.

Butterfly and Moth Conservation: results from a global synopsis of evidence

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In the last few years, global concern over the decline of insect populations has increased, and efforts to assess trends have intensified. Butterflies and moths represent a diverse and popular insect Order with a long history of ecological study and a vital role in ecosystem function, and have become a flagship for insect conservation. But despite a good understanding of their ecology and natural history, how much do we know about the effectiveness of conservation actions for Lepidoptera? While there is an urgent need for conservation action, it is vital that interventions are effective and evidence-based to ensure the cost-effective allocation of resources and delivery of results. We used the subject-wide evidence synthesis approach developed by Conservation Evidence to compile the global evidence for butterfly and moth conservation into a single synopsis, which is freely available online for practitioners and policymakers. I will present an overview of the synopsis, including an introduction to the Conservation Evidence approach, a description of the availability and quality of evidence for global butterfly and moth conservation, and an analysis of the extent to which patterns and biases in the evidence match or differ from other taxa covered by Conservation Evidence synopses.

How to add monetary value to degraded rural landscapes through soil carbon sequestration in natural regeneration?

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Soils can contribute to climate regulation through forest restoration. We present a case study which investigates the soil carbon stock across land-use types in rural areas undergoing natural regeneration seeking to determine the monetary value of carbon sequestered in the landscape to support payments for ecosystem services programs. We collected soil samples from 0 to 30 cm from degraded pastures, young natural regeneration, and conserved native forest in the Doce river basin, in south-eastern Brazil. With the soil bulk density and soil organic carbon we calculated each land-use carbon stock and converted it to CO₂. Based on the current “Amazon Fund” value (\$5.00.Cton⁻¹.ha⁻¹), we estimated the monetary value of soil carbon sequestration per hectare if degraded pasture areas were restored with assisted natural regeneration in 8 years, with the difference between carbon stocks averages. The main results show the average carbon stock in forests is higher (79.0±16.0 C.Mg.ha⁻¹) than in natural regeneration sites (64.6±10.4 C.Mg.ha⁻¹) and pastures (57.6±10 C.Mg.ha⁻¹). Considering only the soil, the conversion of a pasture into a young forest could represent an income increase of \$128.00 ha⁻¹ in 8 years, enabling the creation of a public payment scheme.

The fetish market of Lomé, Togo: An alarming hotspot for the trade of globally threatened species

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Direct wildlife harvesting is one of the most pressing threats to biodiversity, especially in the tropics. While in Asia the issue of wildlife trade for uses other than food, such as traditional Chinese medicine, has attracted a lot of international attention and scientific study, in Africa the vast majority of research has been focusing on bushmeat hunting and trade, which have led so many of the continent's species to population collapse if not to the brink of extinction. However, comparatively very little light has been shed on the extent and impacts of wildlife trade for traditional uses other than food in Africa. The local use of wildlife as fetish is prevalent along the coast of the Gulf of Guinea. Here we report on the fetish market of Lomé, Togo, the largest in West Africa. Market surveys were conducted in July 2021 and February–April 2022. Globally threatened species were widely and openly sold. These include many Hooded and African White-backed Vulture (CR), pangolins (EN/VU), primates, hornbills, among many other bird, mammal and reptile species. All vendors come from Benin, and many species are unlikely to originate from Togo. Accurate figures on numbers and prices will be given during the presentation.

Water management impacts on food availability for wet grassland breeding waders

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Agricultural intensification and drainage of wet grassland reduced the breeding habitat of many grassland waders in Europe. Therefore, re-wetting of drained grassland is the most applied conservation intervention in restoring the breeding habitat of waders. From 2019–2021 we assessed and compared rewetted (winter-flooded) sites (n=28) with drained sites in terms of food availability. We sampled transects at the sites for three different prey-items – benthos-animals, soil-invertebrates and arthropods. Benthos organisms were more abundant in longer flooded sections, whereas earthworms and tipulidae-larvae strongly declined in flooded areas. Arthropods did not show any preference, but were indirectly affected through inhibited vegetation growth when flooded. Overall, re-wetting is beneficial for wet grassland breeding waders in many aspects, but a mix relief of flooded and dry sites should be favoured, as they serve as retreating sites for earthworms. It also speeds re-colonisation of flooded

sites after they dried out and dry sites are as well needed as breeding ground for waders. A mosaic of wet and dry sites suits all the different prey types, creates a heterogeneous vegetation structure and therefore suits many different grassland breeding waders, which all have their own habitat preferences.

Potential dispersal pathways within the range margins of ectotherms, can they move in response to climate change?

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Ectotherms should move poleward in response to the changes in temperature and precipitation regimes induced by climate change. Consequently, species may reach new habitats in their northern range-margin that become newly suitable. The ability of a species to track isotherms depends both on its dispersal abilities and on the landscape permeability. However, the current landscape is highly fragmented by anthropogenic habitats such as crops and urban areas that impede or limit movement of individuals. In this context, we seek to determine whether the current landscape allow species to track climate changes in their range-margins? We run habitat suitability models and landscape graphs that simulate ecological corridors for *Hierophis viridiflavus*, *Lacerta bilineata*, *Natrix maura* and *Triturus marmoratus* in their north range margins. With the notable exception of *L. bilineata*, all species are decreasing. Outputs of the models allow to locate explicitly areas lacking corridors therefore prone to limit species range-shifts. For all species, highly cultivated areas are associated with low density of corridors. Finally reachable areas for species inhabiting wetlands are restricted. The restoration of wetlands throughout anthropized landscape is therefore primordial because they could act as steppingstones.

Testing the long-term outcome of a genetic rescue attempt in a small, genetically depauperate population of the endangered New Zealand hihi (*Notiomystis cincta*)

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Translocations can facilitate gene-flow between fragmented populations, introducing new genetic variants that mask deleterious alleles and relieve inbreeding depression (i.e., ‘genetic rescue’). Yet, genetic rescue attempts in threatened populations are underutilised due to uncertainties surrounding outbreeding depression, appropriateness of donor and recipient populations and the duration of beneficial effects. The New Zealand hihi is a threatened passerine with low levels of genetic diversity, whose recovery is hampered by disease outbreaks and reproductive failure. We assessed the long-term (10 years) outcomes of gene-flow through the translocation of 20 immigrant hihi from the last remaining natural population to a reintroduced, pedigreed population on the island of Tiritiri Mātangi. Six immigrants bred, two of these were closely related and only three have descendants in the population 10 years on. One female immigrant left significantly more descendants and is related to over 50% of the breeding population, which was associated with an increase in mean inbreeding level, but we found no evidence that inbreeding depressed early-life survival. Genetic diversity across 18 microsatellite loci increased, but no detected changes in immunogenetic heterozygosity across three Toll-like receptor genes. We highlight the importance of long-term monitoring of translocations that attempt genetic rescue.

Scanning a landscape for High Conservation Value Forests with machine learning

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High Conservation Value Forests (HCVF) play an especially important role as core biodiversity areas and functional components of Green infrastructure (GI), providing habitats to a large number of species and multiple well-recognized ecosystem-level services. However, identification of HCVF their importance for GI prioritization strategies, usually requires costly and time-consuming field surveys. In this work we applied a predictive modelling approach to scan all forest land in Sweden (divided into 5 ecoregions) for the (potential) occurrence of HCVF. We used Random Forest (RF) machine learning algorithm and available high-resolution (10x10m) wall-to-wall spatial datasets describing landscape configuration, topography, forest structural properties and various socio-economic factors. We trained our model and tested its performance using a country-wide HCVF inventory database. The final RF models generated high-accuracy predictions with the results of the 10-fold spatial cross-validation indicating a good predictive capabilities (ROC AUC in a range of 0.86 – 0.88 for all ecoregions). Using a comprehensive set of independent validation spatial datasets we confirmed that the predicted high probabilities of HCVF occurrence actually represent forests with high conservation values.

Long-term changes in bryophyte diversity of central European managed forests against the background of climate changes

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Cryptogamic diversity is a reliable indicator of the state of forest ecosystems. We analysed the variations in bryophyte alpha and beta diversity of central European managed forests over a 20-year time span, based on data collected in 132 plots scattered across Poland, and related them to changes in climatic conditions. We tested differences in species among sites grouped based on elevation, a. s.l., dominant tree species and stand age. Species richness exhibited no significant trend across years, while it significantly increased along with elevation, a. s.l., especially in broadleaved forests. Species richness exhibited a slight, but not significant increase over time in broadleaved forests, no variations in pine dominated stands and significant fluctuations in spruce dominated stands. Number of hemerophobic and strongly hemerophobic species underwent no significant variations across years either. Species turnover remained quite constant, despite a drop being observed between 2008 and 2013. These results show that bryophyte flora of central European managed forests has remained quite stable over the last two decades. This is related to the fact that, despite the general temperature increase, climatic patterns are not consistent across Poland, whose southern part has undergone a rainfall decrease, while its northern part exhibits a slight rainfall increase.

Primary forest dynamics as a template for forest management

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Forest management largely affect ecosystem services and biodiversity. The ideas of considering nature as a template for forest management or “letting nature to do the job” of sustaining functions and biodiversity is present for decades. However, quantitative estimates of various characteristics of primary forests, including characteristics of natural disturbances, are required but rare. We quantified primary forest dynamics including historical disturbance patterns derived

from tree-ring analyses on the large network of sample plots in the primary mountain forests of Central and Eastern Europe. We found continuous gradients from small to large disturbance events. Moderate events (25–75% mortality, >10 ha) represented more than 50% of the total disturbed area and their rotation periods ranged from one to several hundred years. These results highlight a need for sufficiently large and adequately connected networks of strict reserves. In managed forest, natural heterogeneity should be acknowledged by more complex silvicultural treatments that emulate the natural disturbance spectrum in harvest rotation times, sizes, and intensities. Disturbance severities rarely reaching 100% mortality, much longer rotation periods, and high importance of biological legacy (dead-wood) in primary forests calls for much higher level of tree and structural retention in managed forests including the restriction of salvage logging.

Adaptive management of conservation risks

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Adaptive management is both a very valuable tool for conservation and one of its greatest clichés. One of the most common misconceptions is that formal adaptive management is risky and requires large-scale programs with considerable dedicated resources. Here, we faced a decision problem when planning the reintroduction of endangered Yellow-bellied toads *Bombina variegata* in northern Italy. We sought to collect animals for release, but wished first and foremost not to impact the source population. We used a decision tree to set quantitative thresholds of acceptable risks, then used simulations to plan monitoring, implemented actions, and matched monitoring data to predictions to make decisions. Using this approach, we effectively minimized risks to the source, and although releases were ultimately unsuccessful, it allowed us confidence for future attempts. Conservation projects that involve some level of risk can benefit greatly from being managed adaptively: the key is to truly understand some key principles, to have a desire to act rationally and to do some hard thinking.

Functional traits of plants and pollinators explain resource overlap between honeybees and wild pollinators

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Managed and wild pollinators often cohabit in both managed and natural ecosystems. The western honeybee, *Apis mellifera*, is the most widespread managed pollinator species. Due to its density and behaviour, it can potentially influence the foraging activity of wild pollinators, but this effect is often context-dependent. We observed plant-pollinator interactions in 51 grasslands and we explored whether the resource overlap between wild pollinators and honeybees was affected by honeybee abundance, plant functional diversity, and trait similarity between wild pollinators and the honeybee. Resource overlap decreased with increasing honeybee abundance only in areas with high functional diversity of plant communities, suggesting a potential diet shift of wild pollinators in areas with a high variability of flower morphologies. Moreover, resource overlap increased with increasing trait similarity between wild pollinators and the honeybee. In particular, central-place foragers with proboscis length similar to the honeybee exhibited the highest resource overlap. Our results underline the importance of promoting functional diversity of plant communities to support wild pollinators in areas with a high density of honeybee hives. Moreover, greater attention should be paid to areas where pollinators possess functional traits similar to the honeybee, as they are expected to be more prone to potential competition.

Prevalence of anticoagulant rodenticides in European polecats (*Mustela putorius*) from agricultural areas

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Anticoagulant rodenticides can help to reduce rodent overpopulations in agricultural areas, but they also produce harmful effects on natural predators when ingest them directly or by consuming poisoned preys.

We aimed to study the presence of rodenticides in the European polecat (*Mustela putorius*), a renowned rodent consumer. Ten livers per area of roadkilled polecats were analyzed in 4 areas with different intensive agricultural management: Jaén (olive groves), Madrid (cereal fields in protected area), Valladolid (cereal fields with allowed rodenticide use and frequent rodent pests) and Toledo (cereal fields with low presence of rodent pests outbreaks). The samples were analysed by liquid chromatography (HPLC-MS/MS).

Rodenticides were detected in 58% of the individuals in all areas. Contrary to expectations, Jaén showed higher prevalence (70%), followed by Madrid and Valladolid (60%) and Toledo (40%). A total of 4 compounds were detected: bromadiolone (38%), difenacoum (23%), brodifacoum (28%) and flocoumafen (23%). No major differences were observed in the compounds detected between zones, except for Valladolid, where flocoumafen concentration was higher than other areas.

The results reflected a high exposure in all sampled areas regardless of agricultural management. This should be considering when regulating these compounds to search less harmful alternatives for biodiversity conservation.

Combining continuous measures of moonlight and cloud coverage to assess the influence of real moon illumination over wildlife-vehicle collisions

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Wildlife-vehicle collisions jeopardize wildlife conservation and human safety. Including environmental covariates affecting the spatial behavior of wildlife can improve collision forecasts, and a few studies have already focused on how moon illumination affects wildlife-vehicle collisions. However, no study to date has quantified the interplay between moon illumination and cloud coverage, an atmospheric phenomenon decreasing the amount of moonlight reaching terrestrial ecosystems. We modeled the synergistic effect of moonlight and cloud coverage over the number of collisions between vehicles and European roe deer (*Capreolus capreolus*), in Slovenia. Data included complete nation-wide set of daily collisions (n = 49,259) collected between 2010 and 2019 by citizen scientists. Moonlight was measured both as quarters and as the fraction of illuminated moon. Data were modeled through bivariate Gaussian Processes with a Negative Binomial distribution. Treating moonlight as a continuous covariate makes its interaction with cloud coverage more interpretable than using moon quarters, and it also reduced prediction errors. However, the analysis of the NDVI suggests that at some times of the year it could be hard to disentangle the effect of cloud coverage from that of changes in animal behavior driven by vegetation development, as these two components co-vary in time.

Mapping the remaining genomic diversity of African elephants

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Genome-wide data is becoming an integral resource for conservation of species. In African elephants, a handful of genomes has been used to strengthen the case of recognizing savanna and forest elephants as two separate species. Here, we generate and analyse 165 genomes from African savanna and forest elephants in 13 countries, covering most of their current range. Compared to the previously-used traditional genetic markers like microsatellites and mitochondrial DNA, this genome-wide data allows us to infer: 1) a finer-scale population structure and the main trajectories of gene flow, 2) differences in genetic make-up of elephant populations in the different parts of the continent, and 3) demographic processes which resulted in the present-day patterns of genetic diversity. Besides providing essential insights for conservation genetics, this data serves as a valuable resource for conservation management. We identify and optimize a set of standardized genetic markers that will be implemented in genetic monitoring of wild elephant populations, thus, providing an example of genetics can be incorporated in future research and conservation.

Alien and invasive woody plant pathogens in the Czech Republic and predicting their impact on Natura 2000 habitats

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The number of alien and invasive plant pathogens and their impact on natural ecosystems and biodiversity have been increasing in many regions of the world in recent decades. Early knowledge of harmful invasive species and identification of locations and habitats at the highest as well as the lowest risk of invasion and damage are crucial for effective management of invasions and protection of ecosystems and their biodiversity and functions. We compiled a list of alien fungal and fungal-like plant pathogens detected in the Czech Republic, chose eleven species already or potentially harmful to autochthonous woody plants and their communities and developed spatial predictions of i) the environmental suitability for these pathogens in the country and ii) their potential impact on woody vegetation in NATURA 2000 habitats. Expert knowledge species distribution models with GIS were used to solve the task. The maps show high variability in the susceptibility to the invasions within the country, identify the most endangered locations and habitats and suggest a combined effect of the studied pathogens in many of them. We believe our results can help to implement effective management strategies to monitor and control invasions of these organisms and minimize their impact on nature and biodiversity.

Biomonitoring sandy beach marine biodiversity using environmental DNA.

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Sandy beach ecosystems make up over 70% of the world's open-ocean coastlines and provide important ecological, economic, recreational, and cultural services. Threats to these ecosystems continue to accelerate including climate change, sea level rise, global population growth, and coastal development. However, the traditional marine biomonitoring method, the seine net has many problems, for example, it is not effective in heavy waves, misses highly mobile large predators, and is challenging to deploy on a crowded beach. Emerging technologies may provide a solution and this study uses environmental DNA (eDNA) metabarcoding to survey the biodiversity of surf zone fauna. eDNA metabarcoding is successful at detecting surf zone fish and invertebrate species with some surprising detections. Though results are mixed in distinguishing species utilising different habitats within the surf zone. Finally, this study aims to inform beach man-

agers of another potential tool for aiding the conservation of these important but difficult ecosystems.

The consequences of biodiversity-oriented management of forest structure on the breeding success of forest birds – a systematic review of experimental studies

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Recent decades have seen a move towards novel forest management practices integrating biodiversity conservation with other forest uses. Their effects on bird diversity and abundance are relatively well studied, but less is known about demographic processes underlying those responses. To shed light in this issue and to highlight research gaps in the field, we gathered existing evidence on how breeding success of forest birds responds to different experimental manipulations of forest structure. A comprehensive literature search, following a standard systematic review protocol, was carried out on Web of Science, returning 62 studies which fulfilled our criteria. Studied interventions are very heterogeneous and geographically biased towards North America. Selective logging, partial logging and prescribed burning are the most thoroughly researched interventions. Breeding success outcomes vary highly across both bird functional groups and intervention types. Interventions often resulted in improved breeding success only for a limited set of species, and their benefit may be hampered by factors acting at the landscape scale (e.g. high nest parasitism). If productivity of a wide set of forest bird species is to be improved beyond standard management practices, a mosaic of management strategies needs to be implemented and landscape-scale limiting factors must be addressed.

Costs and benefits of grassland reconstruction as an alternative to landscaping in industrial areas

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Restoration of unused urban-industrial areas has great potential for nature conservation purposes. In this study we compare costs related to implementation and maintenance of three different grassland types (intensive park lawn, extensive grassland and reconstructed native eco park) and we evaluate the established vegetation as an indicator of local biodiversity. The implementation and maintenance costs were more than ten folds higher for the intensive park than the eco park despite the higher price of native plant material. The construction of the eco park pays off in 12.5 years compared to the extensive grassland taking into account the lower maintenance costs. The eco park is the most species rich, hosting the highest number of natural constituent species, but also high number of disturbance tolerant species and the highest cover of weed species. The extensive grassland harbour similarly high number of species, but mostly of weedy character. Our results support that reconstructing native grasslands as an alternative to traditional landscaping in urban-industrial areas can be economically and ecologically worthwhile. The higher costs of planning, plant material and implementation pay off in a short time and can lead to a win-win situation for nature and economy.

Planning for the experience of nature in protected areas

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Urbanization threatens biodiversity and also separates people from the experience of nature. This alienation from nature, also known as “extinction of experience”, represents a major concern due to the connections between nature health, well-being, affinity for nature, and conservation support. Protected areas (PAs), which host unique

biodiversity and landscapes, have a great potential to provide high quality nature experiences, but to date research on nature experience in PA is scarce. We explored how nature experience is considered in the design and management of PAs. We conducted landscape architectural analysis of planning documents and semi-structured interviews with landscape architects and managers of 12 highly visited PAs that contain waterscapes in Israel. Our results indicate that the experience of nature was not one of the themes considered important when designing and managing PAs. Instead, the discourse focused on reducing the conflicts between nature conservation and development, notably, promoting design and management solutions that restrict visitors' activity in PAs. These results highlight that attempts to protect nature in PAs may contribute to the growing alienation of people from nature. This has implications for practitioners related to finding solutions that adequately balance providing opportunities for meaningful nature experience and biodiversity conservation in PAs.

Evaluate the return of key-stone large animals (megafauna) to restore European biodiversity under different forecasted social and climate scenarios.

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Estimating the near-future distribution of European large animals (i.e. megafauna) under forecasted perspectives predicts upcoming opportunities and challenges for nature-based solutions in ecosystems restoration and conservation science. New ecological relationships that may be triggered by the future coexistence of humans and large animals in shared landscapes can indeed bring to one hand at the return of fundamental ecosystem services to the European citizens, and on the other hand to the risk of intensive conflict with farmers, undermining tolerance for wildlife and policymakers engaged in conservation. With the aim to develop science-based support for the decision-making process on landscape management in Europe, I will collect and examine, through forecasted modelling, data on the current distribution of European megafauna and trends in land-use abandonment, wildlife tolerance, current species (re-)introduction efforts, and climate change across the continent. With the results, I will indicate future hotspots of megafauna return, which would create potential for biodiversity rewiring through trophic chains restoration, and future hotspots of conflict, thus where megafauna will roam into strategic areas for cropping and farming. The project is part of the TERRANOVA-ITN network, and will be an international collaboration between Aarhus University (DK), Humboldt University (GE), and iDiv Research Center (GE).

The forest that stands beyond: importance of the landscape for mammal species in a deforestation hotspot

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Land-use change is a major threat to biodiversity globally, yet the effects aside from habitat loss, such as the importance of the agricultural matrix, remain poorly understood. The South American Chaco is an environmentally diverse region holding exceptional biodiversity, but experiences one of the highest deforestation rates worldwide. Here, we examined how landscape features determine the occupancy of two medium-sized mammal species: the three-banded armadillo and the crab-eating fox. We fitted single-season occupancy models using camera-trapping records (1) to analyse how landscape composition and configuration influence these species; and (2) to assess the impact of on-site and surrounding landscape elements at multiple spatial scales. Our results indicate that forest cover is important. Particularly large stands of old-growth forest, persisting away of the deforestation frontier. However, its relevance varies by species and, most interestingly, its effect is stronger at considerably greater distances than predicted. For species that have been historically persecuted, big forest patches seem to be acting as the last refuges from hunting. Contrarily, habitat-generalist species are less affected

by deforestation although responding to human presence and disturbances. Information derived from this study could drive specific management decisions fostering production and conservation alike.

Freshwater community shifts following war-driven declines of large savanna mammals

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Tropical savannas are globally extensive and ecologically invaluable ecosystems subject to serious anthropogenic stress. Defaunation, and especially the loss of large mammals, is pervasive in tropical savannas and known to trigger wide-ranging ecological effects, from vegetation changes to the loss of ecosystem function. However, virtually no research has investigated the effects of defaunation on small adjacent water bodies. This research gap persists because 1) tropical savannas have been historically neglected, 2) the ecological value of small water bodies is only recently being recognised, and 3) empirical baseline data is often lacking. In this study, we compared a rare pre-defaunation dataset with recently collected data on 213 freshwater assemblages, to investigate community structure and composition before and after a major defaunation event. Our research focused on a diverse species assemblage of amphibian larvae in temporary savanna ponds. Pond vegetation cover increased from 16.0% to 45.6% post-defaunation, i.e. a near three-fold increase. While some species have benefitted from such habitat changes, others have declined. These results shed new light on the potential role of large-bodied mammals in shaping adjacent ecosystems, and raise important questions concerning the functioning of temporary aquatic systems in the Anthropocene.

An alien pathogen fungus may alter the natural regeneration dynamics of a keystone forest tree species throughout Europe

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Pedunculate oak (*Quercus robur*) is a European keystone tree species, hosting a great amount of biodiversity, but its future role in (near-) natural forests is uncertain due to the lack of natural regeneration. The scientific discourse on the main factors impeding its natural regeneration is biased because knowledge from historical and non-English literatures is unassessed and the real impacts of an introduced pathogen fungus remain unknown. We reviewed historical and recent ecological, pathological and forestry literature on topics related to the impact of non-native oak powdery mildew (PPM) on the success of advanced natural regeneration of pedunculate oak in (semi-)natural forests. We propose the novel 'oak powdery mildew' hypothesis, to explain the failure of natural regeneration of pedunculate oak throughout its distribution range. PPM reduces shade tolerance and vertical growth in pedunculate oak seedlings and saplings, so sapling vitality and competitiveness have diminished considerably since PPM was unintentionally introduced to Europe in the early 20th century. We found that forest ecologists and conservationists often overlook the impacts of this 'recent' driver. Our study suggests that nature conservation and forest ecology should pay greater attention to the impact of introduced microorganisms and to the integration of knowledge from historical and non-English literature.

Understanding the fine-scale, spatiotemporal drivers of species distribution and abundance for mobile species conservation.

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Mobile species pose a unique challenge to conservation management globally. Established techniques are inherently static and hence are inadequate for monitoring and protecting mobile species with dynamic distributions in space and time. State-of-the-art remote sensing datasets offer high spatiotemporal resolution data covering a breadth of ecoclimatic variables. Here, we demonstrate statistical modelling methods that incorporate these variables, using an example of an African nomadic bird species. The models accurately project both inter- and intra- annual distributions and abundances at high resolution across large spatial extents. We explore the applications of these projections for mobile species conservation, such as assessing species vulnerability by monitoring range and abundance changes over time, or targeting priority sites and timing for action. Moreover, utilising the Google Earth Engine cloud platform, we demonstrate that these dynamic remote sensing variables can be easily incorporated into statistical models with minimal computing power, time and storage demands. We suggest that the generalised methods presented should be readily applied to other taxa and systems, with the potential to advance the conservation of mobile species worldwide.

Predicting support for conservation regulations: Novel applications of the New Ecological Paradigm in protected area landscapes

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Understanding human beliefs in relation to the environment can help predict support for conservation interventions and assess, a priori, the likely success of policies. Protected areas are one of the most widespread conservation interventions globally. However, they are not always supported or received positively by people living in their proximity. Here we present preliminary results from two large-scale studies which used, for the first time, the New Ecological Paradigm to measure the pro-ecological orientation of people living around protected areas within two study landscapes, one in Indonesia and another in Tanzania. Preliminary results revealed very modest pro-environmental beliefs at both sites, with marginally higher pro-environmental beliefs in Indonesia compared with Tanzania. Additionally, we found links between pro-environmental beliefs and the perceived morality of illegally extracting resources from protected areas; those with stronger pro-environmental beliefs viewed rule breaking as somewhat more immoral than those with opposing beliefs. Whilst, due to the many and varied barriers and opportunities influencing behaviour in specific situations, we caution against expecting a strong NEP-behaviour relationship, our findings suggest that the New Ecological Paradigm can be used to predict support for conservation regulations.

Velocity and magnitude of global change in mountain areas

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Mountain ecosystems are being rapidly transformed by global change drivers such as climate change and human use, yet little is known about how these anthropogenic pressures combine and interact to reshape the planet's mountains. Here, we quantify the spatial change in climate, land use and human population density in global mountain areas, identifying areas that might be most at anthropogenic risk by 2050. We analyse multiple scenarios of socio-economic development and resulting global change projections to estimate different metrics of change: magnitude and velocity of change and change in area of analogue conditions. Our analysis disentangles areas that are exposed to different pressures or to a suite of simultaneously-occurring pressures. We highlight areas where an acceleration in global change could pose a threat to mountain biodiversity. Alternative

emission scenarios mean priorities for policy intervention must be dynamic and adapt to rapidly changing conditions. Yet, we found that several tropical mountains are predicted to suffer from accelerating human pressure, regardless of the scenario considered. A classification of mountain areas in which climate change acts together with direct human pressure in the future can highlight different management possibilities, as well as how different emission scenarios are projected to influence mountain regions.

Should the biodiversity bank be a savings bank or a lending bank?

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Conservation offsets are increasingly used as an instrument for biodiversity conservation on private lands. Since the restoration of degraded land often involves uncertainties and time lags, conservation biologists have recommended that credits in conservation offset schemes be awarded only with the completion of the restoration process. What is ignored in these arguments, however, is that such a scheme design may incur higher economic costs than a design in which credits are already awarded at the initiation of the restoration process. A generic agent-based ecological-economic simulation model is developed to explore different pros and cons of the two scheme designs, in particular their cost-effectiveness. The economic model compartment considers spatially heterogeneous and dynamic conservation costs, risk aversion and time preferences in the landowners. The ecological compartment considers uncertainty in the duration and the success of restoration, and the metapopulation dynamics of a species described by rates of local population extinction and the colonisation of empty habitat patches. It turns out that whether credits should be awarded at the initiation or with completion of restoration depends on the ecological and economic circumstances, such as the dynamics of the conservation costs and the restoration uncertainty.

A global overview of biodiversity offsetting governance

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We analyze the development of biodiversity offsetting governance through a research-weaving approach. Here, we combine information from a systematic review of the literature with a qualitative analysis of the institutional developments in different world regions. Through this triangulation, we synthesize and map the different developments of biodiversity offsetting governance around the globe over the last few decades. We find that there is a global mainstreaming of core principles such as avoidance, no-net-loss, and the mitigation hierarchy. Similarly, pooling and trading of offsets for unavoidable residual damages becomes more widespread. Furthermore, we can observe an ongoing diversification of institutional designs, and actors involved. Together this constitutes an emerging regime complex of biodiversity offsetting governance that comes with both a set of shared norms and a growing institutional complexity. While this may imply institutional innovation through diversification and policy experimentation, it also raises questions regarding the effectiveness of different offsetting practices.

Genomic inbreeding and its consequences for the hihi, a threatened endemic passerine of Aotearoa New Zealand

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In small populations, inbreeding – the mating between close relatives – can exacerbate the loss of genetic diversity and may reduce the adaptive potential of the species. In addition, inbreeding can also prompt a reduction of fitness in a population, termed inbreeding depression.

One of Aotearoa's species of conservation concern is the hihi (stitch-bird; *Notiornis cinerea*), a threatened endemic passerine. In 1995, hihi individuals were translocated onto Tiritiri Mātangi island, and since then, a wealth of life history, pedigree and genetic data has been collected. Together with a recently developed genome assembly and 40k single nucleotide polymorphism (SNP) markers, these resources provide a unique opportunity to measure the impacts of inbreeding in hihi from the Tiritiri Mātangi population. Here, we present individual-based inbreeding levels and infer how severely the population has been impacted by the effects of inbreeding depression. With a genome-wide association approach, we examine whether effects of many slightly deleterious variants across the genome are contributing to inbreeding depression in the hihi, if at all, rather than fewer (but distinct) inbred regions.

My work draws a clearer picture of the adaptive potential of the species to adapt to future challenges such as climate change, and informs conservation management.

The ecological niche and conservation value of Central European grassland orthopterans: a quantitative approach

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The ongoing insects biodiversity decline is tightly related to land-use changes and habitat degradation. To assess habitat quality and to understand the role of anthropogenic activities in shaping habitat characteristics, proper bioindicators are needed. Orthopterans have been previously proposed as promising bioindicators for grassland ecosystems; however, comprehensive quantitative information on their habitat preferences is lacking, which hinders full utilization of their bioindication potential. In this study, we surveyed orthopteran assemblages and quantified local environmental conditions at 476 grassland sites in Central Europe. To model orthopteran habitat preferences, the Maxent approach was employed, which allowed us to detect continuous species responses to chosen habitat characteristics. We calculated ecological niche indices describing niche widths, species optima, and the relative importance of particular environmental variables for a total of 38 analysed species. Evaluation of final Maxent models showed that their predictive power was high for the great majority of investigated species. Red-listed species had significantly narrower niches compared to unlisted orthopterans. The development of quantitative ecological niche indices coupled with the existing time- and cost-effective survey methods, also allowing adoption of citizen science approaches, makes orthopterans an optimal model insect group for assessment of grassland condition and conservation.

Post-release survival of captive-bred Egyptian vultures

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Reintroducing species to their historic range is a popular conservation effort aiming to maintain long-term viable populations of animals. This effort requires proper monitoring of the fate of the animals that are released to the wild to assess their success. Nevertheless, effective monitoring is often missing in conservation translocations. We assessed the efficiency of different monitoring methods and estimated survival of captive-bred Egyptian vultures *Neophron percnopterus* that were released to the wild during the first 15 years of a reintroduction project. First, we compared observations to location data from GPS transmitters. Then, we used GPS data to estimate survival of vultures that were released to the wild at different ages and different seasons. Finally, we compared the survival of captive-bred and wild-hatched Egyptian vultures. We show that GPS data was significantly better than observation data. We also show that release protocol and

origin (captive-bred or wild-hatched) did not alter survival during the vultures' first migration or during their first two years post release or post fledging. Our results show the importance of continuous and effective monitoring and confirm the efficacy of captive-breeding and release of Egyptian vultures as a conservation tool.

Elevated fires during COVID-19 lockdown reveal protected area vulnerability

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There is little robust, quantitative information on the impacts of the COVID-19 pandemic on the extinction crisis. Focusing on Madagascar, one of the world's most threatened biodiversity hotspots, we explore if the cessation of on-site protected area management activities due to the pandemic were associated with increased burning inside protected areas. We identify monthly excess fire anomalies by comparing observed fires to those predicted based on historical and contemporary fire and weather data for all of Madagascar's protected areas, for every month 2012–2020. Through to 2019 excess fire anomalies in protected areas were few, short in duration, and in some years coincident with social disruption linked to national elections. By contrast in 2020, COVID-19 meant on-site management of Madagascar's protected areas was suspended from March to July. This period was associated with 76–248 % more fires than predicted, after which burning returned to normal. At a time when international biodiversity conservation faces unprecedented challenges, our results highlight the importance of on-site management for maintaining protected area integrity.

Non-target effects of Bti-based mosquito control on dragonflies

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In Europe, mosquitoes are widely controlled through applications of *Bacillus thuringiensis* var. *israelensis* (Bti) to wetlands. Although direct effects of Bti seem to be restricted to dipteran larvae, effects on non-target fauna are possible through trophic interactions. Field surveys reported conflicting results, partly finding no effects but sometimes observing widespread effects of Bti on dipteran predators including dragonflies (Odonata), spiders (Araneae) and birds (Aves). To test for a causal relationship between Bti and dragonfly populations, we set up a replicated field experiment with twelve artificial ponds mimicking permanent pools in river floodplains. Bti was applied to half of the ponds three times per year over two seasons. Dragonfly exuviae were collected, identified and prementum length measured for two species. Numbers of dipteran larvae in benthos samples was reduced in Bti-treated ponds, and emerging dragonflies were smaller, indicating food shortage. Numbers of emerging Libellulidae, but not of the larger-bodied Aeshnidae, were reduced in treated ponds, indicating negative effects of Bti through food shortage and/or intraguild predation. Our results demonstrate a conflict between Bti-based mosquito control and dragonfly conservation. Since Bti is often applied in protected areas, its environmental safety should be reconsidered.

Ongoing effects of the salamander-killing chytrid fungus *Batrachochytrium salamandrivorans* on salamander populations in northwestern Europe

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The mass extinction of amphibians presents a major part of global biodiversity loss, and anthropogenic pathogen spread is an increasingly documented threat to the survival of amphibian populations. While the fungal pathogen *Batrachochytrium dendrobatidis* has been implicated in worldwide declines of frog species and populations, its sister species, *Batrachochytrium salamandrivorans* (Bsal), has been signalled as an emerging conservation threat to global salamander diversity. We performed a multidisciplinary and international assessment to the continued effects of Bsal invasion on wild fire salamander (*Salamandra salamandra*) populations, a highly susceptible European species. For this purpose, we combined monitoring data from citizen-science programs with novel survey efforts to evaluate: 1) ongoing population dynamics and disease prevalence; 2) extant demographic structure and recruitment; 3) spatial population patterns and habitat associations; and 4) host resistance and population genetic effects. Our results highlight variable population-level impacts, indicating low-level population persistence but also an apparent extinction event. Additionally, we found enduring signs of age-structure truncation, disparate population clustering and habitat associations, while we found no indications of increased host resistance but also no signs of marked genetic deterioration. Our results provide new post-outbreak conservation prospects and avenues for ongoing research in the midterm after Bsal invasion in Europe.

Multi-level habitat selection by a forest specialist in a spatially heterogeneous landscape

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Whether managed forests can serve as habitat for species that depend on old-growth structures is still unclear. We investigated three levels of seasonal habitat selection by the white-backed woodpecker, a species typically found in deciduous and mixed old-growth forests, in forests differing in age and structure. Based on data of 50 radio-tracked individuals, we found that areas with a high proportion of old deciduous stands were selected for establishing pre-breeding and breeding home ranges. By contrast, the proportions of all forest types within post-breeding, summer/fall, and winter home ranges corresponded to their availability in the landscape, and during all seasons, the forest types were used according to their availability within the home range. Modeling foraging tree selection revealed that the probability of use increased with the diameter of the tree and was highest for snags; these relationships were similar in all habitat types and seasons. Our results indicate that old deciduous forests should be present as breeding habitat but that all other forest types can be used during the non-breeding season when suitable foraging trees are available. Managed forests can thus serve as non-breeding habitat for this old-growth forest species as long as they contain large-diameter trees and deadwood.

Identifying factors that influence the rediscovery of missing terrestrial vertebrate species

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Some species that are lost to science are rediscovered. These species are sometimes referred to as Lazarus taxon. The frequency of these rediscoveries is increasing over time, which suggests there are more missing species that may be rediscovered. As these missing species tend to be highly threatened, it is important that we find them and develop measures to protect them before they disappear forever. There has been no global review of the spatial, temporal and taxonomic distribution of missing and rediscovered terrestrial vertebrate species. Yet understanding their distribution may improve our ability to find missing species. Through a literature review and consultation

with members of the IUCN SSC and Re:wild, we build a database of missing and rediscovered species. We use this database to identify broad patterns in their distribution. For each missing and rediscovered species, we then collect data on a series of variables in order to identify factors that influence the rediscovery of missing species. Our global maps reveal regions which may be hotspots for future rediscoveries. Larger species and those with broad habitat preferences are more likely to be rediscovered, whilst those threatened by alien species are less likely to be rediscovered.

Changes in aquatic macroinvertebrate community in a protected alpine pondscape over a 20-year period – Investigating fingerprints of climate change impact

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As climate change increasingly threatens biodiversity, we need to monitor closely the ecosystems at risk. Alpine waterbodies are particularly vulnerable to changes in temperature and precipitation, and the rarefaction or extinction of boreo-alpine species is expected.

Located at high altitudes (>2600 m, a. s.l.) in the Swiss national park, the pondscape of Macun is relatively well protected from most anthropogenic pressures and represents an ideal setting to study the effects of climate change on alpine pond biodiversity. Given their potential as sentinels of global environmental change, the ponds of Macun have been regularly monitored since 2002, with aquatic macroinvertebrate sampling and physico-chemical measurements.

Our investigations evidenced that the macroinvertebrate diversity has remained quantitatively stable between 2002 and 2021, with no significant trend regarding species richness ($p > 0.05$). Community composition has slightly changed ($p < 0.05$), but with no expected decline in boreo-alpine taxa. Long-term water temperature data (2005–2021) were investigated and do not show a perceivable trend towards warming, contrarily to the global pattern described for the same period in the Alps.

In conclusion, our current data do not yet reveal impacts of climate change on the biodiversity of Macun's pondscape. It remains therefore crucial to continue to monitor these sensitive and preserved ecosystems.

Quantifying complex impacts of targeted supplementary feeding for the conservation of a threatened bird population

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Effective conservation of threatened populations requires targeted and evidence-based mitigation of key demographic constraints that limit population viability. However, realised population-wide impacts of conservation interventions may be complex, with conservation outcomes depending on both temporal variation in impacts on target individuals, and impacts on non-target conspecifics (e.g. different age classes). Yet, such impacts are rarely quantified, hindering robust assessment of conservation efficacy.

Using a long-term demographic dataset on the threatened Scottish red-billed chough (*Pyrrhocorax pyrrhocorax*) population, we quantified the demographic consequences of a multi-year (2010–2018) supplementary feeding programme on target juvenile survival, and assessed collateral impacts on non-target adults. Multi-state mark-recapture analyses show that management successfully increased juvenile survival, but that efficacy varied both within and among years. Furthermore, before–after control–impact analyses showed that feeding increased the probabilities of adult survival and successful reproduction, with substantial population-level benefits. Consequently, the supplementary feeding intervention substantially increased the probability of population persistence. This case study of science-informed conservation management demonstrates that supplementa-

ry feeding, a widely used conservation tool, can have strongly beneficial conservation effects, and illustrates how full assessment of intervention impacts can affect assessment of short-term efficacy and thereby subsequent management decisions.

Climate connectivity modelling across European terrestrial habitats highlights movement corridors for range-shifting species

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Climate change often make species to shift their range so that they remain in their climatic niche. However, the intensity of climate change, the intrinsic dispersal ability of species and the anthropization of landscapes can impede species movements. In this context, preserving and promoting climate corridors for species to migrate from their current habitats to their future climatically similar habitats is an important strategy for preventing species extinction. We modelled connectivity between climate analogues across Europe under various ecological assumptions and future climate change scenarios, in order to identify areas of high potential connectivity and to quantify variation in connectivity across a range of hypotheses. We also overlapped connectivity maps with protected areas to determine whether climate connectivity was sufficiently protected. We showed that climatic connectivity did not differ much between different scenarios of climate change, but was strongly dependent on species' dispersal assumptions. Next, we constructed models that depict climate connectivity between observed climate analogues during the past decades, and confronted them to empirical changes in butterfly communities. Overall, our results have the potential to serve in the construction of land cover change scenarios to identify the best strategies to improve climate connectivity.

Landscape-scale connectivity and fragment size affect species composition of grassland fragments

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As a consequence of agricultural intensification, grassland biodiversity has declined considerably in Europe. We assessed how variation in fragment size (small vs. large) and landscape configuration (connectivity index), affect plant and arthropod diversity. We studied two threatened grassland ecosystems in the Hungarian Great Plain, 30 forest steppes, and 30 burial mounds (kurgans). Forest-steppes are natural mosaics of undisturbed dry grasslands and small patches of forests in a matrix dominated by plantation forests. Kurgans are ancient burial mounds that harbour moderately disturbed natural grasslands surrounded by agricultural fields in the Eurasian steppe and forest-steppe zone. We focused on the diversity pattern of plants, spiders, true bugs, wild bees, and wasps. We found that fragment size, connectivity, and their interaction affected species and generalist species abundances of forest-steppes and kurgans. Large fragments had higher species richness, and the effect of connectivity was stronger positive for specialist arthropods and stronger negative for generalists in large than in small fragments. However, we also found a strong positive impact of connectivity for generalist plants in large kurgans in contrast to smaller ones. We conclude that enhancing connectivity between fragments by increasing the amount of natural and semi-natural habitats via restoration would help maintain grassland biota.

Differential effects of nitrogen addition on terrestrial invertebrates: a global meta-analysis

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Anthropogenic nitrogen (N) inputs not only alter soil and vegetation characteristics, but may also affect terrestrial invertebrate communities. Local studies are, however, typically insufficient to uncover general response patterns. Here we performed a meta-analysis of 3,871 observations from 124 papers reporting the effect of N addition on the abundance or richness of terrestrial arthropods or nematodes worldwide. We explored how different N addition levels together with environmental and trait moderators shape the response of invertebrates while controlling for the heterogeneity between studies and phylogenetic relationships between invertebrate groups. We found that arthropods performing a full metamorphosis decreased in abundance with increasing N, while those with incomplete metamorphosis may increase in response to N addition. Moreover, arthropods without metamorphosis presented an optimum of N after which they may decrease in abundance. Nematodes abundance increased with N in wet areas (high precipitation) but decreased otherwise. Arthropod richness was not affected by N, while nematodes richness showed an optimum but negative response. These changes in invertebrate's communities due to anthropogenic N can ultimately affect their ecosystem services such as decreased pollination or increased pests.

Effects of insect pollination on crop quality: A global analysis

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Insect pollination directly benefits the reproduction of a wide share of crops. Despite the importance of pollinators in contributing to global food security and health, much of the research has focused on quantifying their contribution to crop yield, while a comprehensive assessment of their role in enhancing food quality is still lacking. We focused on investigating the effects of the pollination service provided by insects on crop quality by applying a systematic literature review, and by summarising relevant studies through a set of multi-level meta-analyses. We included 112 articles studying the effects of pollination, and extracted over 800 effects sizes about more than 30 different crops worldwide. Results indicate that pollinating insects significantly contribute to increasing quality of all crop types. Physical attributes, such as crop size, shape, and commercial grade significantly improve with pollination, while nutritional and biochemical composition does not seem to be affected. The positive effects on crop quality were observed independently of pollinator species, biome and methodological approach. Our results highlight the need for implementing pollinator conservation and management actions, to ensure crop quality and improve food marketability.

Keep it or leave it – the role of reversible conservation investments in optimal reserve design under climate change

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Climate change causes range shifts of species and habitats, making existing reserve networks less suitable. Reserve networks may be adapted in two ways: by providing additional funds and/or by allowing for the sale of sites to liquidate funds for new purchases. However, due to general negative ecological consequences, selling is often regulated, thus rendering the optimal reserve site selection a problem of irreversible investment. On the other hand, allowing for sale may be interpreted as an investment with costly reversibility, as involved transaction costs do not allow for full recovery of the initial

investment. Whether allowing for sale to increase flexibility under climate change outweighs the costs remains an open question. We develop a conceptual climate-ecological-economic model to find the optimal solution for the reserve site selection problem under changing climatic conditions and different policy scenarios. These scenarios differ in terms of whether and when additional funds are provided, and whether selling of sites is allowed. Our results show that the advantage of allowing for sales is large when no additional funds are available and decreases as the amount of additional capital for adaptation increases. Finally, providing a one-off payment initially instead of regular payments improves habitat protection.

Effect of microclimate on deadwood organisms

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It has been hypothesized that certain wood-dependent organisms are decreasing due to increased competition from species favored by forestry or warming climate. If so, species assemblages on clear-cuts in the north are becoming more similar to managed forests in the south, while species favored by clear-cuts may spread also to other forests and compete with northern species. By calculating "Community temperature indices" and measuring inner-log temperature, we test in this research project for the first time hypotheses related to this. We expect that i) southern species are in the north favored by the increased level of light induced by clear-cuttings, and ii) that inner-log temperature affects saproxylic beetle assemblages. In 2021, we installed 450 elector traps along a 1200 km long latitudinal gradient in Sweden. These traps consisted of 1.5 m long spruce logs and caught all emerging beetles from April until September. They were set up under three different light levels and their inner-log temperature was measured hourly. Now, we are analyzing the collected data and at the conference we will be ready to present our newly acquired knowledge on how microclimate alters wood-dependent species composition.

SYSTEMATIC CAMERA-TRAPPING AND OCCUPANCY ANALYSIS TO ASSESS OCCURRENCE AND CONSERVATION STATUS OF CRYPTIC MAMMALS IN TROPICAL FORESTS

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The tropical forest biome contains a disproportionately high number of mammals with high levels of endemism. However, these forests are undergoing severe human encroachment. Considering the current extinction crisis, monitoring often little-known endemic or threatened populations is vital for assessing their vulnerability and identifying priority areas for conservation. To this purpose, camera-trapping represents a critical tool and by analyzing detections in occupancy framework it is possible to assess variations in occurrence in relation to anthropogenic factors. We applied a systematic camera-trapping protocol (minimum of 60 sites sampled per area) in three areas of great conservation importance in Tanzania. In the first area we detected for the first time in Tanzania the IUCN-Vulnerable African golden cat, while in the other areas we studied the Endangered Sanje mangabey. We modelled occupancy with anthropogenic and environmental factors to assess habitat preferences and vulnerability; for the mangabey we also predicted occupancy across its entire distribution range. Both species displayed vulnerability to humans, with occurrence clearly decreasing in proximity to forest edges nearing human settlements. Systematic camera-trapping coupled with occupancy analysis is an efficient tool to study cryptic species in remote areas and can provide solid information to support management decision-making.

Amphibian detection dog reveals the secret life of newts on land to support their conservation

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Amphibians are important to research, conservation and landscape planning. Their aquatic detection is well established, but terrestrial detection remains complicated. One possibility is the use of trained detection dogs. While reptile detection dogs are well documented in science, the use of amphibian detection dogs remains understudied, especially in Europe. We trained a detection dog to search for crested (*Triturus cristatus*) and pond newts (*Lissotriton vulgaris*) in their terrestrial habitats. First, we assessed the dog in 101 blind tests, where he had to find and safely alert at a previously hidden newt. Second, the dog was deployed six times on each of seven natural transects and compared to visual surveys of those transects and artificial retreats. In the assessment, the dog achieved a detection rate of 92%. Detection rates were temperature and habitat dependent and slightly higher for crested newts and for males. On the natural transects, the dog detected 163 retreats, while no other method was able to detect newts on land. Newts preferred high vegetation cover, small burrows and roots of large trees. When environmental factors are considered, the use of professionally trained amphibian detection dogs will improve data collection for research, conservation and management.

Implementation of a modern sampling design for the revision of the red list of fungi for Switzerland

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The first red list of the fungi for Switzerland is currently being revised. For the three-year field campaign to gather new fungi record data, we implemented an innovative sampling design encompassing both forested and grassland areas and aiming at efficiently covering fungi occurring in common and rare habitats. The study-site selection process was based on modern sampling techniques, such as unequal probability sampling, balancing across several abiotic and biotic variables, and geographical spreading. Habitat information from the Swiss National Forest Inventory and from a novel high-resolution habitat map were incorporated. Additional sites were chosen from 'hotspot' areas with previous knowledge of fungal diversity. Furthermore, we will integrate data from different environmental DNA sources. During the first sampling year, 46 professional and volunteer mycologists contributed nearly 10000 fungi records originating from 108 plots. There was a trend towards higher diversity in grassland 'hotspot' sites compared to grassland sites from the Switzerland-wide selection. No such pattern could be detected for forest sites. A preliminary comparison of the data to the first red list campaign revealed that the new design led to higher relative numbers of red listed fungi. The new sampling design can help other countries to implement similar fungal monitoring programs.

Training citizen scientists for invasive species monitoring with wildlife detection dogs

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Wildlife detection dogs (WDD) are often used to survey biodiversity, especially to detect particularly hidden and cryptic species. However, training WDDs is costly and time-consuming, thus the amount of experts is low. Contrastingly, many private dog owners are looking for meaningful activities for their dogs. The project IGAMon-Dog therefore aims at enabling dogs and their owners to become voluntary WDD-teams to help monitor invasive species.

We chose three invasive plant species as targets: *Fallopia japonica*, *Impatiens glandulifera* and *Ambrosia artemisiifolia*. The program aims to make training and field methods understandable to dog owners to enable independent training and, after validation, field surveys.

After five months, half of the first 15 participants have been able to train their dogs to detect their target scent. Participants state they benefited by deepening their bond to their dog and by gaining knowledge. We thus assume that the program is rewarding enough to bind dog-owners as long-term participants. The training benefits both scientists and citizens and seems to offer great potential. However, it requires a substantial effort, precision in training and supervision of the volunteer WDD-teams by experts. Thus, the cost-benefit ratio must now be examined to draw conclusions about its wider applicability.

Recent range shifts of birds, moths and butterflies are driven by the width of their thermal niche

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A warming climate drives species to move towards the poles and higher elevations. There is, however, large between-species variation in the success of range shifting, highlighting the importance of identifying what characterizes species' ability to track the changing climate. Ecological traits like size, dispersal propensity, overwintering mode, and habitat use have been theorized to explain these differences. However, such traits only sporadically coincide with range shifts and provide insufficient means for explaining species range shift responses. Recently, the adaptive capacity of species, defined by their plasticity in utilizing environmental space, has been suggested to provide a key for distinguishing between species that are more prone to move versus those that stay and adjust to new conditions. In our study, we related the realized changes in northern range edges of 87 bird, 45 butterfly, and 242 moth species across a 1100-km latitudinal gradient over 20 years to the species thermal niches. We find that species occupying a more narrow thermal niche across their European distribution show stronger shifts towards the north. This result was largely consistent among the species groups and point to similar drivers, which are likely connected to thermal niche mean and breadth as opposed to direct ecological traits.

Landscape-level habitat amount affects the species density of deadwood-dwelling lichens

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Habitat loss is a major threat for biodiversity, but the scales on which its effects occur are poorly understood: is the amount of available habitat important for species occurrence on both local and landscape scale? Recognizing the correct scale is critical for successful nature conservation. We studied the importance of local and landscape-scale habitat amount for deadwood-dwelling lichens in Swedish boreal forests. We surveyed lichen assemblages in 90 forest stands that differed in the local (stand-scale) dead wood amount, and in the landscape-scale habitat amount (estimated as the amount of dead wood or old-growth forests, on scales 300 m – 5 km). Lichen species density increased with the landscape-scale, but not with the local habitat amount, whereas species composition was not affected by the habitat amount on any scale. The best measure for landscape-scale habitat amount was the proportion of old (> 100 years) forests on 5 km scale. The results indicate that to benefit the studied species, the amount of old forests in managed forest landscapes should be increased and dead wood restoration or retention should be directed to landscapes with a higher proportion of old forest. Increasing only the local dead wood amount would not benefit the species.

Tracking animal movement to inform the design of effective ecological corridors in agroecosystems

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Ecological corridors are a key solution for enhancing landscape connectivity and mitigating biodiversity loss due to fragmentation. Yet, empirical evidence on the factors facilitating viable wildlife movements within areas designated as corridors is scarce. Here, we aim to explore how different landscape attributes and agricultural management practices interact to influence species movement along a proposed national corridor within an intensive agriculture area. Using a cutting-edge animal tracking technology (ATLAS), we monitored at high-resolution (8 seconds fix interval) the regional movements of 16 bird species (with a total of 157 individuals, 10,000 days, and over 57 million localizations). This massive dataset revealed that species differ substantially in their movement behavior and corridor usage. For instance, both white-spectacled bulbul (*Pycnonotus xanthopygus*) and Syrian woodpecker (*Dendrocopos syriacus*) strongly avoided cultivated fields within the suggested corridor, while traveling exclusively along uncultivated (wild-growth) field margins. In contrast, other species like the European greenfinch (*Chloris chloris*) and common kestrel (*Falco tinnunculus*) readily crossed open fields, resulting in higher connectivity through the landscape. Our findings emphasize the importance of various landscape features for facilitating species-specific movements within the agro-ecosystem and the benefit of high-resolution movement tracking for improving the design and management of effective ecological corridors.

Towards Sustainable Fisheries: Forgotten Catch of Small-Scale Bottom Set Nets in Northern Adriatic

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Fisheries discards, disposed catch of unwanted species or sizes, pose a significant threat to marine ecosystems. While global and regional estimates are available, assessments of macrobenthic invertebrate discards in small-scale fisheries are scarce. In this study, we quantified discards and their taxonomic composition in small-scale bottom set net fisheries in the Northern Adriatic Sea. The total catch of single-layer gillnets and three-layer trammel nets was monitored by on-board observers during regular fishing operations in 2019 and 2020. Target catch and discarded vertebrate species were determined and weighed on board. A random quarter of disposed invertebrates was subsampled for detailed laboratory analysis. Preliminary analysis indicates an average discard rate of 75.4% (SD: ± 16.7%). Organisms belonging to the Porifera, Mollusca (Gastropoda, Bivalvia), Echinodermata, Chordata (Tunicata) and Arthropoda (Crustacea) have jointly contributed 98.3% (IQR: 97.4 – 99.1) of wet weight. We estimate that a median of 47.2 kg (IQR: 25.6 – 65.5) of discards are produced per gross revenue of 100 €. Our results show that regional discard rates can be up to three times higher than global estimates and suggest that the small-scale fisheries impact on marine ecosystems may be underestimated.

Selective effect of fish farming management on freshwater diversity

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Many studies have indicated the negative effects of high fish stocks on the diversity of macroinvertebrates. Nevertheless, the effect of fish predation on invertebrate communities could be strongly influenced by the behavior of individual species as well as other factors, such as the structural complexity of aquatic vegetation. Consequent-

ly, we aimed to analyze the habitat selection behavior and the effects of environmental–trait interactions on the responses of amphibians, odonates, aquatic true bugs, and diving beetles that are directly or indirectly related to pond management. No congruence between habitat specialists and generalists was observed, but a similar response to fish and vegetation structure defined both semiaquatic and aquatic organisms. Moreover, each monitored group reflected very different variables. Odonates were sensitive to variables reflecting the quality of the aquatic environment and the overall landscape structure, and accurately reflected differences in the management intensity of ponds. Our results highlight the significance of habitat selectivity for structuring freshwater ecosystems. However, fish farming management is a selective mechanism that operates with such intensity that there is no morphological or phenological variability among species.

The attractiveness of bird species to humans – the iratebirds.app citizen science project tells us which birds are the most likable to us

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Humans are fascinated by the astounding diversity of forms and colors of wildlife species. There are many examples of the cultural importance of wildlife species. Yet, understanding the attractiveness of species is of importance also from a scientific standpoint. Amidst a global biodiversity crisis, shedding light on the factors that make us like a species or another can inform conservation actions, e.g. leveraging flagship potential, and help identify threats. Despite many attempts to quantify bird species' attractiveness to humans, there is so far no global database on bird species' attractiveness to humans. We present a data set on the attractiveness of bird species to humans using visual appearance. The data are based on an internet browser-based questionnaire (iratebirds.app) where people were asked to evaluate the spontaneous attractiveness of bird species based on the best quality photographs from the Cornell Lab of Ornithology's Macaulay Library database. The rating was done on a scale of 1–10 and the scores were modeled to create the final database. The data set covers all the bird species and subspecies globally, with respondents from 78 home countries, and it is the first such attempt to quantify the overall attractiveness of all the bird species to humans.

Exposure of ape habitat to extreme events and climate change impacts

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Despite increasing awareness of climate change impacts on ecosystems, climate change is still often not considered in conservation planning. To support evidence-based conservation decision-making at site level (that is, the spatial scale at which conservation interventions are typically implemented), we created the A.P. E.S. Wiki (wiki.iucnapesportal.org). This open-access platform provides site-level information on ape conservation status, threats, and conservation activities based on information compiled from papers, reports and experts. Here, we compared information from 59 sites across West Africa to better understand the extent to which climate change has already been taken into account. For only three sites, we found that climate change is listed as a threat, such as the occurrence of droughts and extreme temperatures. Conservation measures to mitigate the impact of climate change have only been implemented at one site. Additionally, we extracted climate and climate impact data from the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP, www.isimip.org), which provides data products modelled consistently across impact sectors, time and space, to address the lack of data at site level. We then mapped the exposure of each site to climate impacts and climate extremes, and provide the results in the A.P. E.S. Wiki to make information accessible to conservation decision-makers.

Combining pure and mixed beech stands to maximize biodiversity and conservation value in temperate European beech forest landscapes

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Diversifying forests is regarded beneficial for productivity, stability, and biodiversity. In Central Europe, mixed forests with the naturally dominating European beech are currently promoted. However, effects of tree species diversity can vary among species groups and can lead to shifts in species composition challenging natural communities. By combining 41 mature forest stands of pure beech, beech/oak, beech/spruce and beech/pine, we investigated the effect of distinct combinations of these forest types on gamma-diversity of 12 species groups ranging from vertebrates to belowground fungi. Using a resampling approach, we searched for landscapes that integrate overall multidiversity and the diversity of beech forest specialists. Besides tree species identity effects, we found that highest gamma-multidiversity was reached in virtual landscapes exclusively composed of the three mixed stand types, while landscapes of pure beech forests were least diverse. The diversity of rare species followed this pattern. Pure beech forests, however, best conserve beech forest specialists of different fungi groups that were most sensitive to admixing other tree species to pure beech forests. Thus, landscapes favoring multidiversity and rare species may not be able to conserve the natural species composition of beech forests to the same degree, indicating trade-offs when it comes to defining conservation priorities.

Native expansive dominants threaten the diversity of plant communities in a way comparable to alien invasive species

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Invasive alien plants reduce the local diversity and contribute to the homogenization of plant communities on larger scales. In this study, we selected 10 native and 9 invasive dominants and compared their impacts on the within-community scale. We identified populations with these target dominants and recorded plots with their varying cover (~dominance) within each population. The impact was then estimated using LMM regressions, relating the species richness and diversity to the dominants' cover. The impacts were compared using the slope/intercept ratios of LMM regressions, accounting for a priori different species richness and diversity of recipient communities.

Native dominants, such as *Calamagrostis epigejos*, *Phalaris arundinacea* or *Urtica dioica* reduce the diversity in a magnitude similar to invasive dominants, such as *Fallopia* sp. div. Furthermore, we compared the impacts of native versus alien dominants, selected as to occupy the same habitats. Native *Calamagrostis epigejos*, *Phalaris arundinacea* and *Cirsium oleraceum* had stronger impacts than alien *Aster novi-belgii*, *Impatiens glandulifera* and *Lupinus polyphyllus*, respectively. However, *Aster novi-belgii* and *Rumex alpinus* had larger impacts than native *Tanacetum vulgare* and *Cirsium heterophyllum*.

Our results support the idea that management efforts should aim to suppress dominant species in general, regardless of their origin.

A simple measure of habitat heterogeneity is a good proxy of species of conservation concern

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Biodiversity assessment is a fundamental part of sustainable forestry and biodiversity conservation. Nevertheless, measuring biodiversity is far from simple and remains a challenge for practitioners who must make management decisions and report the national state of biodiversity at the EU-level. We tested if habitat heterogeneity or a set of habitat amount measures could predict biodiversity in Swedish boreal forests. We used 77 mature coniferous forest stands varying from simple production forests to valuable woodland key habitats to evaluate the relationships between habitat diversity, habitat amount and richness and abundance of species of conservation concern (SoCC) belonging to fungi, bryophytes, lichens and vascular plants. We found stand level habitat heterogeneity to be the best measure to explain the richness of SoCC, but when only red-listed species were included, deadwood volume and age of the oldest tree proved to be more precise proxies. However, the more intensively managed southern region revealed an alarming species loss; despite the habitat availability, the average species richness was only half of the richness in the north. We conclude that habitat heterogeneity can be used as a reliable proxy of the species of conservation concern, but it must not be used to prioritize conservation between geographical regions.

The importance of remotely sensed forest structural variables for identifying bat habitats and habitat restoration sites in forests

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Enhancing structural complexity in multifunctional forests, e.g. through retention forestry, is an important strategy to support forest biodiversity, yet its evaluation requires area-wide and sufficiently precise information on key structural elements and associated species' habitats. As bats respond to forest structures at multiple spatial scales, we tested the importance of forest structure variables derived from stereo-aerial photographs in relation to topographic, climatic and land-use variables for studying bat habitat selection inside forests.

Acoustic data was collected on 135 plots in the Black Forest, Germany. Species distribution models were calibrated for 8 bat species or acoustic groups, thereby identifying the best-performing scale (stepwise increasing radii between 50 – 1000 m around each location) for each predictor and species (group). Forest structural variables such as the percentage of standing dead trees, tree volume and forest height heterogeneity best explained bat habitat selection, mostly at small scales (50 – 100 m), contributing on average 46 % to overall model performance. To assess the benefit of retention forestry for bats, we finally compared key structural variables and the predicted habitat suitability across forests with and without retention measures. The results highlight the value of remotely sensed structural variables to identify areas for bat conservation.

The socio-ecological extinction vortex as a novel concept for conservation science

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A concept of the species extinction vortex is well-established in conservation biology, and proved to be useful in addressing multiple processes that reinforce each other creating together a vicious cycle leading

to extinction. We propose to upscale the concept to habitat level for habitat types that are essentially socioecological systems. We illustrated the concept application to semi-natural habitats, *hotspots for biodiversity in agricultural environments. We identify four highly interlinked and mutually reinforcing socio-economic processes for semi-natural habitats: (i) agricultural production, (ii) policy, research and development; (iii) vocational education in the fields of agricultural sciences and (iv) public's experiences with semi-natural habitats. We review evidence from six countries in the boreal region to demonstrate how the socio-economic vortex might lead to the continuous declines in such habitats area and ecological quality, despite a considerable effort into their conservation. We suggest research directions to ascertain the phenomenon, monitor its development and develop proactive actions to weaken the vortex.

Do protected areas work as 'safe havens' for avian communities in a warming climate?

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Conservation of biodiversity relies heavily on protected areas but their role and effectiveness under warming climate is still debated. We estimated the climate-driven changes in avian community structure inside and outside of protected areas. To study community changes, we used large-scale survey data of breeding birds from Canada. To describe the temperature preference of bird communities, we calculated the community temperature index (CTI) annually for each bird community inside and outside protected areas. A high CTI value represents a community dominated by warm-dwelling species. We modelled temporal changes in CTI as a function of protection status using linear mixed effect models. In addition, we studied which species contributed most to the temporal changes of bird communities. Our results show that CTI is lower inside protected areas. However, against our hypothesis, CTI increased faster inside protected areas compared to outside areas, and the warm-dwelling species contributed most to CTI change within protected areas. These results highlight the ubiquitous impacts of climate change. Currently, protected areas can aid cold-dwelling species by providing suitable habitats, but the community compositions inside protected areas quickly approach those outside the protected areas, potentially erasing the conservation benefits of protected areas for cold-dwelling species.

Mapping roadless areas: mission impossible?

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Roadless Areas (RAs) continue to be underestimated in their contribution to protecting ecosystem functionality and biodiversity. A main constraint for the take-off of RAs research is the lack of open-source road datasets that are complete enough to identify RAs of conservation value. We conducted a comparison of RAs using OpenStreetMap in the Canadian boreal biome and the temperate biome of Central Europe. Using a 1 km buffer for all OpenStreetMap roads, we identified in total 16,786 RAs in Canada (4,560,608 km², representing 84% of the area) and 3,524 RAs in Central Europe (2,160.6 km², only 0.41% of the area). Then, we tested the accuracy of RAs identification in the boreal biome in Canada using two methods (1)1000 random points buffered with 1 km radius, and (2)30 randomly selected RAs; both were visually-manually checked for unmapped roads. In Canada, 26.1% of the buffered points contained roads, of which 23.2% contained unmapped roads; 68% are RAs and were predominantly located in the northern region of Canada. We documented a loss of 68% of roadless surface after manual road-mapping in boreal Canada, a region considered largely unfragmented. This study aims to emphasize the importance of accurate road mapping to identify remaining RAs of ecological value.

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Beetle community response to commercial thinning in boreal forests

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The global need for renewable energy has led to an increasing interest in bioenergy from boreal forests. While having a large potential for renewable energy, these forests also host a wide variety of species, several of which are red listed. The harvest of biomass for bioenergy may cause structural homogenization, potentially increasing the threat to biodiversity. In this project we have investigated the question if biomass extraction for bioenergy can be combined with biodiversity conservation in managed forests. Most research on effects of biomass harvest on biodiversity has taken place in final felling operations. In this study we turn our eyes toward thinning operations. We sampled the beetle community using flight intercept traps to evaluate how understory retention in thinning operations affect the beetle community in managed hemi boreal forests. Preliminary results indicate that the beetle community in plots that were thinned differ from plots that were left unharvested. Interestingly, species diversity increased after both thinning methods. This indicates that reduction of tree density affects both species composition and richness. We found no differences between the two different thinning methods, indicating that retention of understory has little or no effect on beetle assemblage.

Pressures on boreal riparian vegetation: insights in interactions between anthropogenic pressures.

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Riparian zones are species-rich and functionally important ecotones that sustain physical, chemical and ecological balance of ecosystems. While scientific, governmental and public attention for riparian zones has increased over the past decades, knowledge on the effects of the majority of anthropogenic disturbances is still lacking. Given the increasing expansion and intensity of these disturbances, the need to understand simultaneously occurring pressures grows. We have conducted a literature review on the potential effects of anthropogenic pressures on boreal riparian zones and the main processes that shape their vegetation composition. We visualised the observed and potential consequences of flow regulation for hydropower generation, flow regulation through channelisation, the climate crisis, forestry, land use change and non-native species in a conceptual model. The model shows how these pressures change different aspects of the flow regime and plant habitats, and we describe how these changes affect the extent of the riparian zone and dispersal, germination, growth and competition of plants. Main consequences of the pressures we studied are the decrease of the extent of the riparian zone and a poorer state of the area that remains. This already results in a loss of riparian plant species and riparian functionality, and thus also threatens aquatic systems and the organisms that depend on them. We also found that the impact of a pressure does not linearly reflect its degree of ubiquity and the scale on which it operates. Hydropower and the climate crisis stand out as major threats to boreal riparian zones and will continue to be so if no appropriate measures are taken. Other pressures, such as forestry and different types of land uses, can have severe effects but have more local and regional consequences. Many pressures, such as non-native species and the climate crisis, interact with each other and can limit or, more often, amplify each other's effects. However, we found that there are very few studies that describe the effects of simultaneously occurring and, thus, potentially interacting pressures. While our model shows where they may interact, the extent of the interactions thus remains largely unknown.

Understanding the influence of numerous urban environmental factors on avian physiology

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Urbanization is rapidly altering habitat characteristics across the world, with significant effects on wildlife. However, we still lack understanding of which urban environmental factors cause what effects, especially on a physiological level. Here, quantified several environmental factors linked to urbanization: air pollution (PM2.5 and NO2), ambient temperature, artificial light and tree composition within 29 territories of breeding Great tits (*Parus major*). We linked these environmental factors to the physiology of the nestlings using three biomarkers: circulating fatty acid composition, antioxidant capacity and an oxidative damage marker (malondialdehyde), in addition to mass and wing length. Through this novel approach, we could connect several physiological responses to urban environmental factors, including a significant reduction of antioxidant capacity of nestlings with increased levels of PM2.5 but also number of oak trees, and an interaction between the local number of non-native trees and artificial light sources on nestling mass. Moreover, by performing a principal component analysis (PCA), we show that these results would likely not be detected if the common method of urbanization indices were to be used instead of specific environmental factors. Taken together, we show the need for detailed, mechanistic studies to fully understand the effects of urbanization on wildlife health.

The Scandinavian Mountains Green Belt – a unique intact forest landscape of European importance

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The European Union's last large intact forest landscapes occur along the Scandinavian Mountain range in Sweden with 2.5 million hectares boreal to sub-alpine forests. Harboring a high proportion of well connected natural forests, it represent a region with unique opportunities for conservation of biodiversity, maintained ecological integrity and rural development based on multiple value chains. Additionally, it represents a core dispersal source for many species currently threatened in the strongly fragmented landscape east of the mountain range. With wall-to-wall land-cover data, we explored opportunities for maintaining intact forest landscape values through regional spatial planning. The area includes a high proportion of protected high conservation value forests, covering almost 2 million ha, but additionally over 500,000 ha remains unprotected. Of the unprotected area, non-industrial private landowners own more than 40% in more than 40,000 individual holdings – representing a major planning challenge. The area is also part of Sapmi, the traditional land of the indigenous Sami people, and critical for their reindeer husbandry. Our results provide input into ongoing policy implementation and green infrastructure planning in the context of securing intact forest values and integrative opportunities for rural livelihood.

Quantifying effects of wetland restorations on bird communities in agricultural landscapes

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Restoring wetlands to improve habitats for birds has become an important conservation tool as many species are in decline due to vast habitat loss and deterioration. To what extent such restorations are effective is not well known because surveys usually either lack data before the restoration or means of correcting for background trends. We gathered all available Before–After survey data on birds from Swedish wetland restorations in agricultural landscapes. We then quantified the effectiveness of 30 wetland restorations for 75 bird species from the resulting heterogeneous survey data, and used national survey data to correct for background population trends. While restoration measures seemed to benefit about half of the breeding wetland bird community, many species did not show a clear positive response to wetland restorations and some declined. Estimated species responses to restorations were highly site-dependent and variable, which we attribute partly to variability in methodology and lack of robust survey designs. We argue that if policymakers and environmental protection agencies set clear instructions and provide support for proper survey designs to assess effects of restorations, our ability to learn about the effectiveness of restoration actions could be greatly improved.

Human–elephant conflict mitigation as a public good: what determines fence maintenance?

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With hundreds of human and elephants deaths in India annually, reducing human–elephant conflicts (HEC) is essential for elephant conservation as well as social justice. Non-lethal electric fences placed around villages are a widely used intervention to mitigate HEC. In order for such barriers to work, beneficiaries have to act collectively to maintain the fence, making it a ‘public good’. However, despite their effectiveness when maintained, a majority of these fences are poorly maintained. Thus, our central question was why some fences in the landscape are well-maintained and others poorly-maintained. We studied 19 such fences in northeast India using an interdisciplinary approach, combining qualitative comparative analysis, Ostrom’s social–ecological systems (SES) framework, and a grounded theory approach incorporating ecological and qualitative social science tools. We find that contrary to our hypothesis, there are three potential pathways of maintenance; (1) a community maintainer, (2) the community self-organizes, and (3) the forest department. Maintenance occurs when there is a congruence between perceived costs and benefits for any one of these entities. These include not just material benefits but also intangibles like goodwill, sense of safety, social standing, and a feeling of fairness. We highlight these factors and provide recommendations for practitioners and policy.

Genomic divergence and a lack of introgression between commercial and wild bumblebees, *Bombus terrestris*

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Human-mediated movement of non-native commercial bumblebees used for pollination services can affect local pollinator populations via hybridization. However, the extent of genomic introgression and evolutionary divergence between wild and commercial bumblebees has yet to be fully explored.

A deeper understanding about the consequences of introgressive hybridization is important since wild populations could be faced

with the potential disruption of locally adapted genes through introgression of maladapted alleles originating from escaped commercial bumblebees. Thus, affecting the wild population’s ability to adapt and withstand future environmental change.

We compared whole genome sequencing data from wild (WB) and commercial (CB) *Bombus terrestris* from sites in southern Sweden with long-term exposure to imported *B. terrestris* and sites without such exposure. We examined evidence of introgression, dispersal and genome-wide selection signatures between the two groups. Despite the detection of CB individuals in natural environments at sites where CB were used, we found no evidence of genomic introgression among WB and CB in southern Sweden, suggests that the use of CB does not pose a genetic threat to local *B. terrestris* populations. We identified a highly divergent region on chromosome 11 of CB, which provided evidence for differential evolutionary processes operating on WB and CB.

Untangling the climate vs biodiversity crisis dilemma: sustainable windfarm development at a global biodiversity hotspot

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Renewable Energy Sources (RES) are listed high in the EU and national environmental policy agendas, embracing ambitious climate goals, though on a tight schedule, for the upcoming years. However, a rapid expansion of RES without adequate spatial planning could jeopardize biodiversity conservation efforts and consequently undermine climate change mitigation actions. In this study, we focus on wind energy in a biodiversity hotspot, namely Greece, where the investment interest exceeds sixfold the 2030 national target, while existing legislation and the current spatial RES planning framework allow windfarm development even within the Natura 2000 network. At a national scale, we showed that by excluding windfarm installation from Natura 2000 sites and areas of low fragmentation the 2030 national target can be met without compromising biodiversity conservation. Moreover, with a current threefold higher land take per unit of power compared to generic estimates, we found that windfarms consume more land as their size increases and when installed at areas without other infrastructures and/or with more rugged topography. Therefore, such areas should not be opted for sitting windfarms at a local scale. If incorporated in spatial RES planning, our results could minimize the ecological footprint of windfarms, while meeting both climate and biodiversity goals.

Greece shows the way for a roadless policy in Europe: links with the European biodiversity strategy

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Road sprawl is a key catalyst of land-use change, the greatest threat to biodiversity worldwide, and its negative impacts on biodiversity and ecosystem function are well documented. Although Europe is the most fragmented continent of the world, the reduction of fragmentation from roads and artificial land does not appear in the key commitments of the European Biodiversity Strategy. In January 2022, Greece has endorsed the first national roadless legislation in the EU. The “Untrodden Mountains” governmental project has used scientific evidence to impede road and artificial land expansion in six large mountainous roadless areas (0.74% of Greek land) aiming at fragmentation mitigation and effective biodiversity conservation. Research is ongoing, involving extensive road mapping using satellite imagery. We have identified 55 roadless areas over 10 km² (2.42% of Greek land), whilst over 60% of the 774 smaller candidate areas (1–10 km²) and 90% of the 3642 islands evaluated are expected to be added to the national roadless map when completed. We suggest roadless policy expansion in Greece and the EU, by integrating roadless areas in the criteria of (a) defining strictly protected zones, (b) expanding and interconnecting Natura 2000 sites, (c) defining rewilding restoration targets in the European Biodiversity Strategy.

Temporal changes in grassland bumblebee communities are buffered by local and landscape-level floral availability

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With bumblebees facing an uncertain future under global climate change, systematic monitoring can improve their conservation by indicating vulnerable species, such as through changes in species distributions. In this study, we assessed temporal changes in bumblebee communities in semi-natural grasslands throughout Sweden over the last 15 years. The structure of bumblebee communities (i.e., density and richness) exhibited considerably temporal variability, a result driven by directional changes in the distributions of common species. In particular, the occurrence of the long-tongued species, *B. hortorum*, has declined considerably in the north of Sweden, whereas several short-tongued species (*B. jonellus*, *B. lapidarius*, *B. pratorum* and *B. soroeensis*), show the opposite pattern. Our results also demonstrate temporal phenological changes in several species' activity periods. Floral resource availability was the key determinant of bumblebee densities in semi-natural grasslands. All species responded positively to increased local floral abundance, but the landscape-level availability of late-season floral resources affected bumblebee communities more so than early season resources. Ensuring diverse floral resources throughout the year, alongside species-specific conservation plans, are needed to protect threatened bumblebee populations.

Assessing the effects of a brownfield-like substrate aggregate mound on plant and ground arthropod communities in Cambridge, United Kingdom

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Brownfield sites can harbour rich and rare biodiversity, but these sites are increasingly lost to redevelopment. Mitigation measures recreating 'brownfield-like' habitats are proposed, however there is little evidence evaluating their effectiveness. We outline a brownfield-like substrate aggregate mound habitat creation project, and describe the variation in environmental characteristics and plant and arthropod communities. Our results from the first two years of the creation show the potential of a small substrate aggregate mound to significantly alter the environmental characteristics of an area. In particular, the presence of the mound increased canopy openness, lowered vegetation height, increased inorganic material cover, lowered bare ground cover, and reduced temperature, as well as increasing species richness and altering plant and arthropod community composition. Most plant species at the site were found on the mound, the majority of these being self-colonised and over half of the species being early successional. We found that environmental conditions and plant and arthropod communities also varied between years and across the mound. Our findings provide strong evidence that substrate aggregate mounds can increase site heterogeneity and total species counts, as well as harbouring early successional communities, and might thereby be useful in mitigating the wider ongoing loss of brownfield sites.

Balancing the varying effects of functional connectivity provided by landscape green infrastructure habitats for grassland plant communities

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Conservation policy aims to mitigate effects of habitat loss by creating networks of natural and semi-natural features (green infrastructure) which support threatened species and connect isolated habitats. Despite this, the extent to which different habitats provide connectivity for different species and how this influences biodiversity across scales and varying landscape contexts remains unclear. We investigated effects of landscape connectivity on plant community composition, genetic diversity and plant-pollinator interactions in a range of grasslands and grassland-type green infrastructure habitats in 36 landscapes in Belgium, Germany and Sweden. We found that the presence of green infrastructure supports various aspects of biodiversity, contributing to greater local-scale species richness and ecosystem functions and facilitating the transfer of species and genetic diversity between large, highly diverse populations in core grassland patches and surrounding habitats. However, different habitats support very different sets of species, the conservation value of which depends on environmental conditions and proximity to core grassland sites. This is particularly the case for poorly dispersed and specialised species, which do not benefit from spatial links between isolated or lower quality green infrastructure. Hence large, long-established grasslands are key for many species. As such, multiple requirements must be balanced when managing landscape-scale green infrastructure networks.

Improving agricultural life cycle assessment for biodiversity conservation

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Pressured by urbanisation and growing consumption, agricultural production has become more intensive in Europe. Through increasing efficiency, landscapes have become more homogenous, which has been linked to the recent biodiversity loss. National and international strategies aim to combat this loss, but halting it remains a challenge. Thus, we need to increase our understanding of agricultural management strategies that can benefit wildlife. In our study, we collected data of birds and butterflies in two agricultural landscapes in Switzerland. We mapped land use/cover and ranked the importance of different landscape features for species groups. We then investigated the role of surrounding landscape configurations for patch-level biodiversity using statistical models. The results highlight the importance of extensively managed and non-crop habitats. Our models improved when including spatial configurations of patch-surroundings. Next, we used this knowledge to enhance the validity of SALCA-BD (Swiss Agricultural Life Cycle Assessment), an expert-based biodiversity model predicting the impact of agricultural management on different species groups, through adding the spatial context. Including spatial dimensions in biodiversity models will help to overcome shortfalls for the prediction of mobile species. Such models are valuable tools for prioritization of land-use management options through sophisticated spatial planning that favours both humans and wildlife.

Pollinators, pests and yield – multiple trade-offs from insecticide use in a mass-flowering crop

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Multiple trade-offs are likely to occur between insecticide use, pollinators and yield (via crop flowers) in pollinator-dependent, mass-flowering crops (MFCs), causing potential conflict between agronomic and conservation goals. However, to date, no studies have looked at both outcomes within the same system, meaning 'win-win solutions' for pollinators and yield can only be inferred. Here, we outline a new framework to explore these trade-offs, using red clover (*Trifolium pratense*) grown for seed production as an example. Our focal insecticide improved clover yield with no adverse effect on its key pollinator, and the presence of clover in the landscape benefitted pollinator

populations; thus, growing clover under integrated pest and pollinator management (IPPM) is likely to sustain pollinator populations. In a broad context, we discuss our findings and consider how toxicity, spatiotemporal patterns of insecticide use, the pollinator dependency and pest susceptibility of the crop, the surrounding landscape, and the life history of the focal pollinator and pest species may change the shape of the relationships that underpin these trade-offs. This framework applies to all insecticide-treated MFCs and can be adapted to include other ecological processes. We believe this holistic approach is essential to achieve conservation and agronomic goals and fundamental for IPPM.

Effects of different forest management on microclimate: field experiments in oak–hornbeam forest stands

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Stable below-canopy microclimate of forests is essential for biodiversity and ecosystem functionality. Forest management modifies the buffering capacity of woodlands but comparative studies focusing on the effects of different silvicultural treatments on microclimate or the recovery after interventions are still scarce.

With two field experiments, the effects of four different forestry treatments (clear-cutting, retention tree group, preparation cutting, gap-cutting) and gap attributes (shapes and sizes) on microclimate were studied in Hungarian oak-dominated stands.

We found that microclimate changed immediately after the harvests; the effect sizes among treatment types were consistent throughout the years; the climatic recovery time for variables appeared to be far more than three years and the applied silvicultural methods diverged mainly among temperature maxima. By establishing gaps with different sizes (small, large) and shapes (circular, elongated) we revealed that size was the primary driver of light, soil moisture was determined by shape, while temperature changes were influenced by both irradiation and soil moisture. Spatial analyses identified circular patterns for diffuse light and opposing north–south gradients in the case of direct light and soil moisture across gap types.

Spatially heterogeneous and fine-scaled treatments of continuous cover forestry are recommended for maintaining the local climate mitigating capacities of forests.

Public payments for private actions in German forests against the biodiversity and climate twin crises

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Humanity needs to find quick mitigation solutions against rampant climate change. In important parts of the public discourse, biodiversity loss may look less urgent, and indeed a ‘carbonisation’ of environmental policies can be observed. In an attempt to conciliate these potentially competing societal goals, the new German government, in power since December 2021, announced an ambitious payment for ecosystem services programme for forest owners. The Ministry for Environment has asked our team of biologists and forestry experts to formulate and evaluate options for a payment scheme. This scheme shall give monetary incentives only to those forest owners who consent to increase forest naturalness, thus also improving the capacity to adapt to climate change. Targets range from improving deadwood reservoirs and free-willed forest regeneration to exemption of old trees or even contiguous areas from harvest. At the same time the scheme shall pay these forest owners for reducing forest management intensity and thus supporting forests in their capacity as carbon sinks. This talk will report on the results of this research project that is currently ongoing.

One Park, Two Owners – Inconsistencies in Forest Stewardship

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Appropriate management of European spruce forests in this time of climate change is a significant challenge. Uniform principles of quality forest practice must be applied, essentially in forests of high conservation value. However, as we demonstrate, this is problematic in protected areas with mixed ownership and disparate priorities. Managerial decision-making is often based on personal knowledge, priorities other than conservation, or political influence.

In this paper, we compare forest management practices of the state and private municipal owners in Šumava NP, where many valuable Natura 2000 habitats occur. We used high resolution aerial photographs to evaluate the effects of forest management measures, and compared the status of spruce habitats before and after a major windstorm and bark beetle outbreak. We found that follow-up forest management measures have significantly affected forests in Šumava NP negatively. Forest ownership was important for the type and intensity of changes. We compare our findings with experiences from other national parks with similar forest management challenges. Examples of appropriate practice applied in state owned forests together with well-targeted financial incentives are recognized as the most effective tools to reduce the disparities between private and state owners in management of protected areas.

Understanding and predicting climate change induced vegetation shifts in a temperate grassland based on long-term monitoring and field experiments

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Since climate is a major determinant of both the distribution of major vegetation types and the delicate pattern of coexistence in plant communities, changing climate will inevitably lead to shifts in plant species composition. Despite substantial increase in temperature (>1 °C) and changes in precipitation in many regions, well-documented changes in vegetation composition associated with changing climate are rare, and future changes have high uncertainties. By combining a long-term monitoring study and precipitation manipulation experiments, we investigated the effects of extreme weather events (drought) and chronic precipitation change on species dominance in an endemic sand grasslands in Central Hungary. Extreme drought events in the last 20 years led to gradual shift in species dominance from one perennial grass (*Festuca vaginata*) to another one (*Stipa borysthenica*), while the prolonged lack of drought allowed recovery. Drought and watering experiments reproduced these patterns, but went beyond and highlighted that recurring summer droughts lead to a decline of both perennial grasses and induce a shift to annual species. Our results indicate that these grasslands are prone to a major dominance shift in response to repeated summer droughts predicted for the future, with major consequences on ecosystems functioning and conservation of its endemic species.

No evidence that hunting wolves reduces livestock damages in Slovakia

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Lethal actions are among the most controversial issues within large carnivore management and conservation. Variation in the legal status of grey wolves (*Canis lupus*) between European countries provides good opportunities to test if current lethal management practices reduce the number of livestock losses. In this study, we aim to evaluate the influence of a wolf-hunting scheme (i.e., annual hunting

quotas) on livestock depredation levels in Slovakia at the district level. We analyzed the relationship between livestock damages caused by wolves (all livestock species pooled) in individual districts in the years 2014–2019 and the number of wolves killed, factoring in the estimated total number of wolves in each district. We also considered two potential covariables that could influence depredation levels: the number of livestock and the available biomass of wild ungulates. We did not find a relationship between the proportion of wolves killed from the total number of wolves estimated in a district and cases of livestock depredation. A strong negative relationship was observed between biomass of wild prey and the number of damages caused by wolves. If the justification for district-level hunting quotas was to reduce livestock depredations, our results indicate that the action did not accomplish its goal.

The effects of visitor's load on vegetation in 20 nature trails across Estonia: negative effects on diversity prevail independently of habitat type

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Despite the growing popularity of nature tourism, we have very limited comparable knowledge of how tourism affects nature, and what are the effects in different habitats and trail types. Tourism related effects on nature are typically studied in single locations or only for a few specific, typically local flagship species. This approach makes it difficult to compare the effects in different locations, and examine the role of potential mechanisms of how human activities affect nature in nature tourism context. The focus of our study was on the vegetation in nature trails – we wanted to know whether the visitor's load on nature trails has affected the diversity and composition of vegetation. We selected 20 trails from all over Estonia, representing trails in forest, wetland and grassland habitats. The results show that plant diversity along the trails is negatively affected by visitor's load in both forest and open habitat trails, and there were also considerable changes in vegetation composition. Thus, the negative effects on plant diversity appear even in boardwalk trails that go through species-poor wetlands, where stepping outside the trail is unlikely. Geographically and culturally wider sampling in different habitats and trails would show whether such trends are universal.

Effects of isolation on bird communities and their functional traits in fragmented grasslands

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Habitat fragmentation is critical for global biodiversity. To understand its effects, we investigated how local and landscape-scale variables, such as habitat fragment size (small vs large) and landscape configuration (isolated vs well-connected), affect bird species richness, abundance and functional diversity. We surveyed 60 threatened grassland fragments classified into two endangered grassland types: forest-steppes and kurgans. Forest-steppes are natural mosaic habitats occurring in the contact zone between grassland and forest. Kurgans are ancient burial mounds built of earth, spread across Eurasian steppes. In our research area, forest steppes were embedded in forest plantations, while kurgans were surrounded by an agricultural matrix with gradients of size and connectivity. We found that bird communities in large, well-connected forest-steppes had higher diversity and abundance than small, isolated fragments. Isolation negatively affected ground-nesting species in small forest-steppe fragments. Trait similarity of birds on well-connected kurgans was higher than on isolated kurgans. Species with small home range and ground feeding habits were more abundant on well-connected kurgans. Specialist birds had a higher abundance on highly isolated kurgans. These findings suggest that large, well-connected grassland fragments can significantly contribute to the persistence of grassland specialist birds in modified landscapes, thereby maintaining the ecological functionality of these habitats.

Disentangling the effect of forest management decisions and emergent forest structure on forest heterogeneity

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Modern forestry is aiming towards conserving natural elements and improving forest heterogeneity to conserve biodiversity. Forestry can directly affect forest structure through target-oriented decisions or indirectly by the interaction of the local environment on stand growth and structures development (such as canopy cover, diffuse light or disturbances regime). The mechanism for forestry's direct and indirect effect on forest heterogeneity is not precise and may leave space for open interpretation. This study evaluates the effect of direct and indirect management on forest heterogeneity in temperate mixed managed forests.

We used a structural equation model to analyze the mechanism and compare forestry's direct and indirect effect on forest heterogeneity on observed data, simulated mature forest and simulated young forest. Our analysis found that direct management has a stronger influence than the indirect effect on forest heterogeneity in observed data and simulated young forest. However, we found a stronger effect of indirect management effects on heterogeneity for the simulated mature forest.

Our study shows how forest management directly increases forest heterogeneity in the early stages of forest development. This highlights the importance of forest management in the early stages, while indirect effects of forest management are manifested only in mature forests.

Prioritising management action for biodiversity conservation in Catalonia

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The periodic monitoring report of the State of the Nature (2013–2018) in the European Union (EU) shows that biodiversity continues to decline, despite efforts carried out in the last decades. Therefore, improving adequacy of conservation action is urgently needed.

We aimed to identify conservation gaps in Catalonia in period 2013–2018. We collected information on management measures implemented, including allocation, budget, pressures aimed, and habitats/species that potentially benefit. We also mapped the spatial distribution of pressures, species and habitats, and compiled information on the sensitivity of each species/habitat to each pressure. We crossed the information on the distribution of pressures, species/ habitats and measures to identify management gaps (pressures not covered by measures).

We then identified priority areas for filling those management gaps, by using the prioritactions R package, which aims to identify an optimal allocation of management actions to reduce the impact of multiple pressures on multiple species and habitats simultaneously. We found that in many cases resources are not adequate distributed across species/habitats with duplicities of conservation investment a common issue. The gaps identified could be efficiently covered through our spatial prioritisation approach that could help improve adequacy of management efforts across the EU or elsewhere.

Conservation of deadwood dependant lichens in pine forests

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Intensive forestry has led to a decline of important substrates such as deadwood and its associated biodiversity. Deadwood dependent lichens are of great conservation concern due to their dependency of deadwood as well as poor dispersal ability. In a field experiment in central Sweden, we studied deadwood dependent lichens for 8 years, their association to different types of deadwood and their response

to environmental change caused by variable retention forestry, deadwood creation and prescribed burning. We found that red-listed species were completely dependent on old, hard deadwood. Deadwood that was created in the experiment was only colonised by common species. Prescribed burning had a negative effect on deadwood dependant lichens throughout the study period. Conservation action should focus on high quality deadwood that can persist for a very long time. The type of deadwood inhabited by red-listed lichens is rare and takes very long to create. When planning for prescribed burning, special concern should be taken to the risk of causing local extinctions of e.g. deadwood dependent lichens.

Contrasting responses of trophic guilds to forest decline reshape canopy insect communities

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Climate change is increasing the frequency and spatial extent of forest declines and diebacks in Europe. This leads to major shifts in trophic resources and microhabitats, especially in the canopy layer, which is enriched in deadwood resources, but depleted in foliage. We assessed the effects of oak decline on the community of canopy-dwelling insects. To do this, we sampled insects in the canopy of 21 oak stands with contrasting levels of decline, located in three forests, using green multi-funnel and flight-interception traps. We collected more than 129,000 individuals belonging to 1,359 species and 16 larval trophic guilds. Oak decline significantly reshaped the community composition but did not affect the overall species richness and abundance. Decline had contrasted effects depending on the larval trophic guilds considered. Surprisingly, no effect was detected concerning xylophagous and saproxylophagous guilds, but decline negatively affected gall-inducers. However, decline promoted several guilds depending on ground-related resources like rhizophagous and pollinivorous/nectarivorous insects. This suggests that the impact of canopy opening on ground microclimates and resources may be a major driver of compositional change in canopy-dwelling communities during declines. These results also highlight that declining stands shelter peculiar communities and can be an asset for biological conservation purposes.

eDNA for terrestrial arthropods: state of the art and perspectives for management and conservation

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Arthropods is by far the phylum that has the most species and the most individuals-rich of all the animal kingdom. Nevertheless, their effectiveness have dramatically decreased these last decades. Due to technical difficulties to survey and relatively few taxonomists, terrestrial arthropods have drawn little attention in the field of environmental DNA (eDNA). Nonetheless, some pioneer studies and approaches have shown the many promises of arthropod eDNA surveys per se or to achieve terrestrial species distributions knowledge gathering through arthropods. Such methods have bypassed some of the inherent difficulties of eDNA surveys in non-aquatic environments by creative approaches. They have also pointed to difficulties and bias, such as the lack of completeness of barcode libraries that we assessed for spiders, springtails and some insect orders. In addition, such techniques not only address data acquisition and methodological questions but also have the potential to address management and conservation questions. In this systematic review of the literature, we acknowledge and discuss the models, methods and aims of the available literature on eDNA targeting terrestrial arthropods. We also assessed arthropods' barcode coverage by public repositories of genetic data. Moreover, we illustrate a step-by-step procedure with data from a program conducted in French national parks.

Exploring the role of agricultural trade in the future of nature and people

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Agricultural trade has been identified as a leverage point to reverse global biodiversity declines. It however plays a complex role in biodiversity declines from land use change, with heterogeneous net land use impacts across commodities and regions, leaving unclear the potential for a more positive contribution. We explore with the GLOBIOM global land use model the role of agricultural trade in achieving ambitious biodiversity goals. We estimate the environmental (biodiversity, GHG emissions) and socio-economic (food security, value added) impacts of scenarios combining alternative assumptions about trade (exacerbated liberalization, frictions and reconfigurations) and broader efforts to bend the curve of biodiversity loss (ambitious conservation, supply-side and demand-side efforts). Preliminary results show positive socio-economic impacts and negative environmental impacts in a scenario prolongating historical trends. Exacerbated liberalization worsens environmental impacts for mixed socio-economic impacts, while trade restrictions have mild environmental gains and negative socio-economic impacts. High levels of trade could be maintained with much lower environmental impacts if assuming additional conservation and supply-side efforts, pointing to a significant potential for sustainable trade. Assuming additional demand-side efforts is more disruptive, with much larger environmental gains but also large declines in value added and trade flows.

Mapping the impact range of traffic noise on animal behavior in non-urban environments and in protected habitats reveals alarming consequences

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Roads have many environmental impacts, but the consequences of road traffic noise are underappreciated, despite studies showing that traffic noise has substantial negative impacts on wildlife. By reviewing existing literature, we explored the impact ranges of traffic noise on different animal behaviors. We then used these ranges to quantify and map the impact of traffic noise on wildlife in non-urban environments in Israel, with an emphasis on sensitive habitats and nature reserves.

Within 200 m from roads, noise affect hunting efficiency, communication and habitat selection. Over a third of the natural and open areas in Israel are exposed to noise effects in this range, a high value compared to other countries. In addition, about a quarter of the protected areas are within this range. A range of 1,500 m from roads, where most of the impact on habitat selection in birds is expected, represents 76% of the open areas in Israel and 63% of the protected areas. Consequently, for many species, the non-urban and protected areas in Israel are not a safe refuge from the deleterious effects of roads. Our review on the negative effects of noise pollution on animal behavior can be used in other countries to improve conservation efforts.

Value versus values: Drivers of attitudes towards wildlife

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Support for wildlife protection hinges on attitudes towards the target species. Consequently, drivers of attitude have been studied extensively. While traditionally focusing on risks/costs, studies have recently highlighted the importance of wildlife-associated benefits or emotive and normative aspects. Those different factors have not been

considered together, however, and their relative importance remains unclear.

We hypothesized a model of attitude formation that combines those and additional potential drivers. We tested it for data from an online survey on wolves in Germany using partial least squares structural equation models.

Wolves' benefits were the most important driver of attitude, followed by risks, emotive valence, and normative beliefs. Emotive valence had a pronounced effect on perceived risks and benefits, while knowledge had a marginal and no effect, respectively. Social identity influenced attitude indirectly via both normative beliefs and risk/benefit perception.

Our study demonstrates the importance of perceived wildlife benefits for strategies seeking to improve wildlife-related attitudes. The importance of affective valence suggests that purely education-based approaches may be ineffective. Recognizing social identity, in contrast, seems crucial regarding its central role in attitude formation.

Our unifying model combining previously isolated drivers highlights emotive valence and social identities as promising targets for strategies towards attitudinal change.

Farmland bird decline reversed by grassland restoration: a landscape-scale before–after–control–impact experiment

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Farmland bird populations have declined in Europe for decades now, yet farmland birds have not been targeted by ecosystem restoration. We studied farmland bird responses to landscape-scale grassland restoration by grass sowing, alfalfa sowing, and hay transfer in former croplands in a Before–After–Control–Impact experiment. Point count data of 2589 individuals of 12 farmland and 5 common bird species in 78 sites on 910 hectares showed that farmland bird richness increased in both restored grasslands and in extensive croplands, whereas abundance and diversity increased only in restored grasslands but not in extensive croplands. Abundance increased in restored grasslands for five farmland and two grassland species, and in extensive croplands for one farmland and one grassland species. Grass sowing increased both richness and diversity, while alfalfa sowing increased richness and decreased abundance, and hay transfer increased abundance. Extensive croplands had four–five times more species and individuals than intensive croplands. Our results suggest that landscape-scale grassland restoration can locally reverse regional bird declines and is an effective tool in farmland biodiversity conservation. Restored landscapes may also serve as population sources to sink populations in neighboring areas under intensive agriculture.

Distribution, growth and feeding studies of two invasive cichlids (*Vieja* sp. and *Parachromis* sp.) in a natural thermal water habitat of temperate Central Europe

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The outflow of the natural thermal Lake of Hévíz (Hungary) is habitat of several fish species, with nature conservation relevance. In the past few years, numerous thermophile (tropical originated) fishes were reported from this waterbody, from which two taxa (*Parachromis* hybrid, *Vieja* hybrid), characterized with strong, self-sustaining population have been studied. Our aims were (1.) to explore their seasonal dispersal dynamics and (2.) to perform basic population biology (feeding and growth) studies. Our results show that distribution of these species are restricted to the thermal water outflow area during the winter, however they spread rapidly in the spring as the water warms. The Bertalanffy growth equation, compared to other habitats, shows slower growth for both species. The Fulton condition factor val-

ues were $K=2.23\pm0.24$ for *Vieja* and $K=1.69\pm0.20$ for *Parachromis*. In the dietary analysis, we found that detritus (58.1%) and macrophytes (18.9%) constituted a major proportion of the stomach contents of *Vieja* hybrids. Regarding *Parachromis* hybrids, the main food items were macroinvertebrates and fish (31.5%, 30.2% respectively). From our results, it can be assumed that these species have a considerable seasonal impact on the native fauna in the whole watercourse section due to their competitive feeding and predation pressure.

Spatiotemporal interactions of a novel mesocarnivore community in an urban environment before and during SARS-CoV-2 lockdown

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Studying species interactions and niche segregation under human pressure provides important insights into species adaptation, community functioning and ecosystem stability. Due to their high plasticity in behaviour and diet, urban mesocarnivores are ideal species for studying community assembly in novel communities.

We analysed the spatial and temporal species interactions of an urban mesocarnivore community composed of the red fox and the marten as native species, the raccoon as invasive species, and the cat as a domestic species in combination with human disturbance modulated by the SARS-CoV-2 lockdown effect.

We found that species were more often detected and displayed a higher use intensity in gardens during the SARS-CoV-2 lockdown period. All three wild species spatially co-occurred within the urban area. We found that all wild species showed overlapping nocturnal activities. All species displayed temporal segregation based on temporal delay. According to the temporal delay analyses, cats were the species avoided the most by all wild species. To conclude, we found that although the wild species were positively associated in space, the avoidance occurred at a smaller temporal scale, and human pressure in addition led to high spatiotemporal overlap.

The use of lethal methods in arthropod conservation research

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Arthropods are in decline, and several species are threatened. We surveyed the methods used in the two journals devoted to arthropod conservation (Insect Conservation and Diversity, ICD, Journal of Insect Conservation, JIC). Out of the 244 primary papers published in 2014–2018 by ICD, 161 employed lethal methods, and 80 (33.2%) non-destructive ones. When the focus of study was a single species, 57.4% of the papers used non-lethal study methods, while only 24.9% did so when multiple species were studied. In non-tropical regions, 37.0 % of studies used non-lethal methods, while only 13.2% did so in tropical studies. Of the 451 articles published by JIC, 51.2% used lethal methods, and 45.2% non-lethal ones. When studying more than a single species, 66.1% used lethal methods, while with single species focus, 25.9% (44/170) did so. Forty-four % (154/349) of the 349 articles from non-tropical areas, vs. 77.3% (75/97) of the 97 articles from tropical areas used lethal methods. We contend that even if the damage done is negligible, using lethal methods when pursuing research aimed at conserving arthropods puts entomologists in an ethically undefensible position. Non-lethal methods should be used whenever possible.

Evaluating the use of irreplaceability to identify Key Biodiversity Areas, and the effects of geographical scale

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Key Biodiversity Areas (KBA) are 'sites contributing significantly to the global persistence of biodiversity' and they represent an indispensable tool for effective site-based conservation. Sites qualify as KBA under Criterion E if they have a very high irreplaceability value derived from a quantitative spatial prioritisation analysis. The irreplaceability of a site is determined by both the biodiversity found within it and the biodiversity contained in the other sites considered in the analysis, meaning irreplaceability values and patterns change depending on the scale. We found that under the current formulation of Criterion E, the 47% of regionally irreplaceable planning units were not represented in country-level analyses, while country-level analyses mainly represented a subset of the regional ones. This indicated that at the regional level, irreplaceability was driven by endemic species and species richness, while at the country level, exclusively by endemic species. For some areas, the analysis produced very few or no highly-irreplaceable planning units. This could indicate that the current targets were too low for these countries. The KBA Standards and Appeals Committee could take some actions to make the analysis more robust, such as setting the scale of application at the regional level and revising the targets.

The role of fisheries management in conservation of freshwater fish species in the Czech Republic

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Freshwater fishes are among the most threatened organisms worldwide. Fishing restrictions such as bag and slot limits are often used as a conservation tool. They aim to reduce the number of fish caught by anglers. We analyzed the effect of fisheries restrictions and regulations on the harvest rates (yields) of the following freshwater fish species: mainly common carp *Cyprinus carpio*, Eurasian perch *Perca fluviatilis*, European grayling *Thymallus thymallus*, and European eel *Anguilla anguilla*. This way, we analyzed data regarding several million fish caught by several hundreds of thousands of anglers in central Bohemia over 16 years. The result was that the angling restrictions such as bag and slot limits worked like a charm. They almost always resulted in an immediate significant plummet in the harvest rates of the targeted fish species. However, the fishing effort (the number of fishing trips) kept increasing over time, meaning that the anthropogenic pressure on the fish populations was only partially removed by the fishing restrictions. In conclusion, we vigorously recommend using the fishing restrictions since they usually do their job.

Overcoming implicit bias in ecology and conservation publishing

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The global scientific community needs diverse perspectives and leadership to address challenges of international scope such as the biodiversity and climate crises. While there are increasing efforts and successes toward diversity, equity, and inclusion in academia, it is largely unknown if this development is also reflected among top-publishing authors and potential scientific leaders. We surveyed 13 leading journals in ecology, evolution, and conservation to investigate the diversity of the 100 top-publishing authors in each journal between 1945 and 2019. Out of 1051 individual top-publishing authors, only 11% are women. The United States, the United Kingdom, Australia, Germany, and Canada account for more than 75% of top-publishing authors, while countries of the Global South were strikingly underrepresented. The number of top-publishing authors who are

women and/or are from the Global South is slowly increasing over time, and positively correlates with population size and GDP per capita. We outline transformative actions that scientific communities can take to enhance diversity, equity and inclusion at author, leadership, and society level. The resulting promotion of scientific innovation and productivity is essential for the development of global solutions in conservation science.

Assessing species' exposure to climate change to support extinction risk assessments for the IUCN Red List

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The IUCN Red List is a central tool in biodiversity conservation. To best inform policies, it is crucial that it monitors drivers of extinction consistently, especially those of growing concern, as climate change. However, assessors are currently not able to properly evaluate climate change impact across groups, due to the lack and uncertainty of climate change information and worsened by the discrepancy between "well studied" and "less studied" taxa. For example, 28% of threatened birds are considered threatened by climate change vs 10% of reptiles, despite the latter is a group of ectotherms highly sensitive to temperature. Here, we propose a standardized measure of climate change exposure to improve climate change risk assessment. Using terrestrial mammals as study group, we measure the exposure as the difference between the current and the future species climatic niche, defined using current and future bioclimatic variables. Assuming areas outside the future climatic niche are less likely to be suitable, this measure can directly inform Red List Criterion A on population trends and thus allows to identify species that are likely to be threatened by climate change and should be reassessed. Our measure is potentially applicable to all species within the IUCN with range maps.

Resilience of bird communities to alien species in a highly human-dominated landscape

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Alien bird species often negatively interact with native bird species leading to local biodiversity loss and trait homogenisation. Our aim was to assess bird communities resilience to alien bird species in highly human-modified landscape. We surveyed 190 randomly distributed points (stratified sampling: urban, agricultural and forest areas) using point counts around the Tagus Estuary area (Portugal). We ran Hierarchical Modelling of Species Communities models to infer bird co-occurrences response to landscape composition, phylogeny and species traits. Urban and intensive agricultural areas showed lower species richness compared to forested and extensively managed agricultural areas. Urban and intensive agricultural areas were more suitable for alien bird species, whereas forest areas negatively affected alien bird species presence. We found that extensively managed agricultural areas negatively affected abundance of alien bird species, favouring ground feeding specialist species (e.g. *Calandrella brachydactyla*). Our results suggest that alien and generalist native species are favoured in anthropic disturbed areas, whereas forest and extensively managed agricultural areas favour native specialist species richness and abundance. Future management strategies should focus on enhancing habitat quality in more anthropized areas to promote avian diversity and improve resilience of bird communities to alien species.

Organic farming and environmentally-friendly management practices enable complementary diversification of plant-bumblebee food webs

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Plant and pollinator diversity has declined concurrently in Europe in the last half-century. We studied plant-bumblebee food webs to understand the effects of two Estonian agri-environmental schemes (AES; environmentally-friendly management and organic farming) vs. conventional farming, landscape structure (homogeneous, heterogeneous) and seasonality (June–August) interactions. We found that both AES and landscape structure influenced the generality (redundancy in the use of flower resources) of food webs. In homogeneous landscapes, environmentally-friendly management, including restrictions on the application of glyphosates, enhancement of bumblebee habitats (permanent grassland field margins), the allocation of a minimum of 15% of arable land to legumes, contributed to a higher number of visited plant species in July, whereas organic farming did so in August. Therefore, both AES are important to support plant-bumblebee food webs. Food webs generality and Shannon index are affected by a significant interaction between seasonality and landscape structure: food web diversity varied in homogeneous landscapes between the three survey months, whereas food webs were more diverse in heterogeneous landscapes. In homogeneous landscapes, resource limitation is an issue for bumblebees in certain time periods. For supporting bumblebees, avoiding resource limitation is important and this can be secured with a combination of AES management practices.

Identifying ‘climate keystone species’ as a tool for conserving ecological communities under climate change

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Climate change affects ecological communities via their species. The community's response to climate change can be represented as the temporal trend in a climate-related functional property that is quantified using a relevant functional trait. However, some species influence this response more strongly than others. Following a general definition of a keystone species, species that have a strong effect on the community's functional response to climate change beyond their relative abundance can be considered as ‘climate keystone species’. We develop a stepwise tool to determine the species' effects on the community-level response to climate change and identify climate keystone species. We quantify the difference between community's climate change responses including and excluding the species of interest to obtain the species-specific effect on the community's response. Then, we identify as climate keystone species those species with a strong residual effect after weighting with their relative abundances in the community. To illustrate the use of the stepwise tool with empirical data, we identify climate keystone species that have a strong effect on the change in the average temperature niche in North American bird communities over time. Identification of climate keystone species can serve as an additional conservation method to protect ecosystem functions efficiently.

Richness and Redundancy: Spider and Plant Function in Buffered Riparian Systems

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It is commonly assumed that forested riparian buffers protect and enhance aquatic systems through nutrient filtration, erosion reduction, biodiversity refuge, and habitat connection. However, the effectiveness of buffers around aquatic systems is dependent on many factors including size, condition, and upland pressures. Further,

buffer effectiveness is rarely quantified through functional diversity measurements of animal and plant species within the system. We calculated functional richness, functional redundancy, and α -diversity of spiders and plants along 15 streams in southern Sweden using a variety of traits driven by environmental variables and forestry practice. We investigated the effects of buffer size, distance from streams, and abiotic variables regulated by each, against functional measures for spider and plant communities using structural equation models. SEMs showed buffers up to 40 m had higher spider α -diversity, driving spider functional richness. Plant functional richness was driven by α -diversity, buffer density, and canopy closure but had a negative effect on redundancy. To maintain high functional diversity in buffered riparian systems, forested buffers should be large enough to support high species diversity. However, fully forested systems showed lower overall species diversity and may benefit from selective thinning to regulate buffer density and canopy closure to enhance riparian function.

Man vs. Machine – Cost Comparison of Bird-Monitoring Techniques for Result-Based Payments in Agriculture

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Result-based payments (RBP) can improve the cost-effectiveness of agri-environment schemes (AES), but are rarely applied due to a major difficulty: substantial monitoring costs. Within the CAP, so far RBP have been implemented mainly for the conservation of indicator plant species in grassland. Bioacoustics and information technology provide a promising opportunity for extending RBP to wildlife species, such as birds. We compare monitoring costs of RBP for bird conservation in agriculture using either human observation or audiomoths (the least-cost bioacoustics devices on the market) in combination with machine learning using different cost scenarios for the status-quo and future technological development.

Hatching failure and conservation management of threatened birds – a meta-analysis and systematic review

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Avian hatching failure is a widespread phenomenon, affecting around 10% of eggs that are laid and not lost to predation, damage, or desertion. While it is acknowledged that rates of hatching failure are often higher in threatened species and captive populations relative to wild, non-threatened populations, these differences have rarely been quantified and any broader patterns remain unexplored. We conducted a phylogenetically controlled multilevel meta-analysis across 234 studies and 246 species. We found the mean overall rate of hatching failure to be 17%, with threatened species experiencing significantly higher rates than non-threatened species. Across management levels, wild populations experienced the lowest rates of hatching failure, followed by wild managed populations, with captive populations experiencing the highest rates. Similarly, populations undergoing artificial incubation, supplementary feeding, and artificial nest provision displayed significantly higher rates of hatching failure than populations without these interventions. This is the most comprehensive comparative analysis of hatching failure conducted to date, and the first to quantify the associations with threat status and management. We discuss the implications of our results, such as their potential use as a tool for conservation managers when assessing the effectiveness of applying various interventions and determining the best conservation strategy for a species.

Catapulting nature onto the agenda: governance opportunities and barriers of nature-based solutions

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Nature-based solutions (NBS) have emerged as a critical umbrella concept encompassing all actions and measures that use nature's properties to systemically address societal challenges, simultaneously providing a variety of benefits for nature and people. Among their manifold co-benefits, there is great potential for NBS to contribute to human wellbeing, climate change adaptation and biodiversity conservation. However, despite the significant political traction NBS have gained, their implementation often remains too fragmented or context-specific for their wider operationalisation and upscaling. Based on a meta-analysis of grey- and peer-reviewed literature, workshop results and semi-structured interviews, we identify and discuss the institutional, legal, regulatory, social and economic opportunities (N=252), as well as barriers (N=264) to NBS in various contexts. Based on our findings, we suggest innovative new institutions, policies and instruments that can enhance the adoption and mainstreaming of NBS for conservation.

Local and landscape drivers of long-term arthropod trends in Switzerland

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There is growing concern about the human-induced loss of arthropod diversity, abundance and biomass. However, we still know little about the main drivers of long-term changes across different arthropod groups, land-use types and spatial scales.

Here, we analysed data of 1.73 million arthropods (i.e., carabid beetles and spiders) belonging to 877 species that were collected using 51,250 pitfall traps across 44 years (1974–2018) in Switzerland. We examined inter-annual trends in their diversity, abundance and biomass at different spatial scales and across six major land-use types, and we explored the potential drivers (i.e., climate change, land-use intensity and urbanization) causing these trends.

We found fundamentally distinct trends across land-use types that were relatively consistent for both groups. There were moderate local arthropod diversity declines in ruderal habitats and croplands, increases in grasslands and woody linear structures, and non-significant changes in forests or wetlands. Importantly, regional richness in ruderal habitats and croplands declined sharply, highlighting community homogenization as a major process threatening arthropod diversity. Furthermore, urbanization was an important landscape-scale driver of the observed declines.

Our results show that local land-use as well as urbanization at landscape scale drive long-term arthropod changes, and that regional community processes contribute significantly to its decline.

Towards a Holistic Approach to Rewilding in Cultural Landscapes

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In recent years, rewilding has been attracting growing attention as novel, process-oriented concept supporting ecosystem restoration and biodiversity conservation. Rewilding aims to strengthen the adaptive capacity of ecosystems by restoring natural processes and withdrawing anthropogenic interventions. Yet, diverging understandings, conceptions and definitions of rewilding result in a somewhat fuzzy concept. So far, the scientific discussion focused primarily on biological and ecological effects and success factors of rewilding. However, it is argued that, particularly in Europe, which is characterised by densely populated areas and a long history of landscape cultivation,

rewilding incorporates also a socio-economic and socio-cultural dimension which are important from both a theoretical and practical perspective. The aim of this paper is therefore to elaborate on the socio-economic and socio-cultural aspects relevant for rewilding. On the basis of a synthesis of current scientific publications, we identify research gaps and derive recommendations for future areas of research. The need for an inter- and transdisciplinary understanding of rewilding is emphasised in order to provide a holistic perspective on the topic and to support the uptake of rewilding in disciplines related to conservation sciences, decision-making and practice.

Linking landscape-scale conservation to regional and continental outcomes for a migratory species

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Land-use intensification on arable land is expanding and posing a threat to biodiversity and ecosystem services worldwide. We predicted population trajectories of a migratory bird species at a continental scale under varying levels of landscape-scale conservation investments while accounting for hunting regulation. In particular, we linked habitat conservation at landscape scales to equilibrium abundance of a migratory species at the continental scale. To achieve this, we combined a landscape habitat model, fecundity model, harvest model and a full-annual-cycle population-projection model. We applied this novel approach to the northern pintail duck (*Anas acuta*), a species valued by birders and hunters in North America, and well below its population goal. Based on empirical observations from 2007–2016, realistic scenarios for harvest and habitat conservation costing an estimated \$588M (2016 USD) led to predicted pintail population sizes < 3M when assuming average parameter values. Given competing needs for remaining lands and fiscal limitations on conservation funding, our findings indicate that achieving the continental population goal of 4M individuals is unlikely. Using our work as a starting point, we propose continued development of modeling approaches that link conservation funding, habitat delivery, and population response to better integrate habitat conservation and harvest management of migratory species.

A Binational Course-based Undergraduate Research Experience as a model for Sustainability Education

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Anthropogenic realities in the Danube River and its Delta include but are not limited to climate change; pollution; improper plastic disposal; habitat destruction from excessive tourism, urban and industrial sprawl; international shipping; invasive species; and over-fishing. Taken independently or in combination, at the ecosystem level, these disturbances are threatening life (species extinction) while decreasing ecosystem services. For the Danube River and its Delta to be sustainable then, it is imperative that we begin to shift the way we train scientists as our future researchers and environmental leaders. The proposed work will provide ECCB participants with a binational undergraduate research instructional model that not only prepares students for rigorous STEM research through online and field experiences, but also prepares them to take action to address environmental sustainability issues confronting the Danube delta or similar ecosystems throughout their lifetimes through the blueprints of the UN SDGs. Evidence from Romanian and American student assessment research, providing both qualitative (artifacts) and quantitative (CURE Survey) data, will also be presented showcasing how blending course-based undergraduate research experiences (CUREs), short-term study abroad, and sustainability education through our instructional model benefits student learning, especially agentic learning.

Who and where: Wildlife traits as predictors of roadkills of birds and mammals in Latin America

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Roads are a major threat for wildlife degrading habitat and causing direct mortality via wildlife–vehicle collisions. In Latin America, the conjunction of high biodiversity and a rapidly expanding road network is reason for concern. We compiled data from 86 roadkill surveys from Latin America that provided 1682 roadkill rate estimates for 346 bird and 159 mammalian species. We applied Random Forest models to predict roadkill rates considering species' traits, habitat preferences, and the geographic coordinates of each study. Fitted models were used to predict spatial risks for roadkilled species across their areas of habitat. We found higher mortality in larger birds and medium-sized mammals. Birds and mammals with shorter life expectancies, wider habitat breadths, and early maturity ages that occur in anthropized areas showed higher mortality. Diet was the most important trait predictor for mammals, with higher rates among scavengers and those with diets based on invertebrates. Our spatial predictions revealed higher roadkill rates across Central America, northern Andean regions, the Atlantic Forest of Brazil and Argentina, and southern Chile. This first comprehensive assessment for Latin America offers a synthesis of drivers of roadkill risk for birds and mammals and identifies species and areas where existing roads can impact wildlife.

Local adaptation to climate anomalies relates to species phylogeny

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Climatic anomalies are increasing in intensity and frequency leading to higher extinction risk for many species. The impacts of anomalies are likely to vary between species due to different degrees of local adaptation. Here, we used long-term butterfly monitoring data of 143 species across six European bioclimatic regions to show how species' population dynamics have responded to local or globally-calculated climatic anomalies, and how species attributes mediate these responses. Contrary to expectations, the degree of apparent local adaptation showed no associations with species mobility or reproductive rate but did contain a strong phylogenetic signal. The existence of phylogenetically-patterned local adaptation to climate has important implications for forecasting species responses to current and future climatic conditions and for developing appropriate conservation practices.

Global changes in terrestrial, freshwater, and coastal ecosystem extents over three decades

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Land use, climate change, and other pressures cause changes in different ecosystems' extents, altering species' habitats and survival. The IPBES Assessments reported globally and regionally declining extents of most (semi-)natural ecosystems, and the Post-2020 Framework seeks general increases in extents, with associated monitoring burdens. Yet, for most ecosystems and regions, systematic data on change direction and magnitude are lacking. Integrating three decades of environmental Earth observations (>50 satellite-based and

in-situ datasets), we provide an unprecedentedly comprehensive record of global dynamics of land, freshwater, and coastal ecosystems over ~30 years. We find ecosystem extents to be highly dynamic. Artificial ecosystems like pastures, plantations, or mining areas increased substantially, mainly displacing sub-/tropical lowland moist forests. Yet, surprisingly, different (semi-)natural ecosystems' global and regional extents did not decline systematically, exhibiting regional gains and losses and shifts between upward and downward trends, but no net loss on average. This paradox is explained by few, globally extensive and declining ecosystems making room for areal increases in many less extensive (semi-)natural ecosystems, notably many wetland types, as well as in artificial systems. Our results support ecosystem monitoring capacity in data-scarce regions, inform questions on sensible targets and baselines for Post-2020 monitoring, and enable diverse conservation applications.

Rewilding – the farmers perspective. Perceptions and attitudinal support for rewilding among the English farming community.

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As an increasingly common conservation approach, rewilding has the potential to profoundly change landscapes and people–nature relations. Farmers are some of the key stakeholders who stand to be affected by and to influence the trajectory of rewilding initiatives. Using thematic analysis of semi-structured interviews with 36 farmers and farming representatives in England, we show that the diversity of farmers' attitudes towards common rewilding scenarios (beaver release, farm-level rewilding, and landscape-scale rewilding) can be understood through the prism of perceptions on five core issues. These include 1) the perceived need for restoration action, 2) the ecological effectiveness of rewilding, 3) rewilding's compatibility with ensuring food security, 4) rewilding's compatibility with rural lifestyles, livelihoods and economies, and 5) multidimensional justice of rewilding initiatives. Farmers' perceptions on these issues are influenced by individual and collective values, environmental beliefs, and the perceived social and ecological impacts of rewilding initiatives. Diverse perceptions result in a range of attitudes, from enthusiastic to strongly opposed. We argue that where opposition is based on common, value-based preferences, e.g. for 'tidy' landscapes, accommodating for them to increase rewilding's acceptability risks compromising rewilding's own goals, whereas pursuing rewilding ambitions that clash with those values may risk social conflicts.

Simple but massive conservation action leads to landscape-scale recovery of amphibians

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Conservation science should provide the tools to halt and reverse population declines. While it is known that habitat creation can benefit declining populations, reports of positive conservation outcomes are few. We showcase a conservation success story from the canton of Aargau in Switzerland, where hundreds of new ponds have been built over the last decades, mainly for the benefit of amphibians. Amphibians are the most threatened vertebrate group worldwide, and habitat loss is a major driver of population declines. Fitting dynamic occupancy models for 12 amphibian species to 20 years of monitoring data, we show that persistent conservation action reverses negative population trends and leads to landscape-scale stabilization or increases in metapopulation sizes of amphibian species. While there were regional and species-specific differences in the use of

constructed ponds, all species colonized new ponds, which compensated or even overcompensated for declines in old ponds. Testing for effects of local and landscape-scale variables on colonization probability enabled us to make species-specific recommendations to improve pond creation, regarding pond (surface area, water table fluctuations) and landscape characteristics. Simple, but massive conservation action lead to population recovery of threatened amphibian species, and easily implementable rules of thumb can help maximise conservation efficacy.

Better seabirds bycatch data collection can help to identify problems and suggest mitigation measures

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Bycatch – the incidental capture of non-target species in fisheries – has been identified as one of the major threats affecting seabird populations worldwide. In the Baltic Sea, a globally important area for wintering seabirds, bycatch in gillnets represents an important cause of human-induced mortality for seabird species. Countries are required by European law to report official bycatch data, mostly done in a very irresponsible way. This study presents data collection improvements on the total seabird bycatch in the small-scale coastal fishery for the entire Lithuania, in the Baltic Sea, during the winter period from 2015–2020. An average of 19.3% of the total fishing effort were observed each winter season, resulting in observations of 909 bycaught birds from 15 species vs 6 bird in official data. Two species comprised two-thirds of the total bycatch, Long-tailed Duck, *Clangula hyemalis* (42.1%), and Velvet Scoter, *Melanitta fusca* (35.4%). We estimate that between 1,500 and 3,000 seabirds were bycaught annually in the Lithuanian small-scale coastal fishery during the study period. Our study highlights deficiencies and inadequate the country's current bycatch reporting. Alongside improved data collection, effective ways to mitigate seabird bycatch should be developed, starting from alternative fishing gears or mitigation.

Demographic patterns of fertility and embryo mortality in a threatened bird population

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Monitoring reproductive success is an important part of species recovery and reproductive failure can hinder conservation efforts. In birds, small, threatened populations often experience high rates of egg hatching failure, which can be due to either fertilisation failure or embryo mortality. The mechanisms behind these two causes of hatching failure differ, as it is likely that the factors influencing them do. However, distinguishing between fertilisation failure and embryo mortality is not commonplace in the monitoring of bird populations. Using a dataset of over 1,000 failed eggs, laid by 187 females across 8 years, we examine long-term patterns of infertility and embryo mortality, and their association with population demographic factors in a reintroduced, managed population of a threatened bird species, hihi (*Notiomystis cincta*). We find that although average hatching failure rates are stable over time, fertilisation rates vary across years. Variation in egg fertilisation rates is significantly related to population size and sex ratio, which are intrinsically linked; with more females resulting in a larger overall population size. We find that birds lay more unfertilised eggs in years when the population is smaller and the sex ratio more male biased. We discuss these results in the context of conservation management.

A quasi experimental analysis of the impact of new mining developments on deforestation in Zambia

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Mining is vital part of the global, and many national, economies and it is integral to the transition to renewable energy. However, mining also presents a significant risk to the conservation of biodiversity as it has the potential to drive extensive deforestation with impacts reaching far from the mine itself. Accurately quantifying the deforestation impact of mining is important for a number of stakeholders yet the existing literature is limited. To address this gap, we applied statistical matching methods, a quasi-experimental causal inference methodology, and spatiotemporal generalized linear models to assess the impact on deforestation of new mining developments in Zambia from 2000. Zambia is a global significant producer of minerals and is home to miombo woodlands which are vital for biodiversity and the livelihoods of millions of people. We found no evidence that new any of 22 new mines we analysed had increased deforestation compared with matched controls. Measuring the environmental impacts of mines and other development activities requires the application of robust impact evaluation methodologies.

Invader–pollinator paradox: Invasive goldenrods benefit from large size pollinators

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Mutualistic interactions between alien plants and native pollinators are needed to enable plant invasions. Although the increasing abundance of invasive plants in a habitat causes a dramatic decline of native pollinators, pollination services received by invaders are often sustained. This invader–pollinator paradox might be attributed to differences in pollination effectiveness and varying vulnerability to invasion among pollinators with different life history traits. In an experimental study, we explored the relationships between pollinator body size, pollination effectiveness and abundance of invasive species. Body size of floral visitors was structured along with the goldenrod cover so that pollinators' size increased with the cover. Also, the seed set of the potted plants, as well as goldenrod seed viability, depended positively on the body size of visiting pollinators. Invasive goldenrods did not suffer from pollinator shortage and ineffective pollination, especially in habitats densely covered by the invader, due to the presence of large-bodied pollinators. Our study highlights that pollination and reproduction of invasive plants might be sustained through ecological filtering, affecting the composition of pollinators with traits increasing pollination effectiveness.

Pesticides cause an unexpected silent spring in oak forests

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Rachel Carson's warning of a silent spring by an absence of songbirds due to pesticides led finally to a US-wide ban on DDT in the 1970 s. Nevertheless, multiple anthropogenic stressors have continued to increase in global ecosystems, which makes the identification of mechanisms for population declines in observational studies increasingly difficult. We tested the effect of aerial tebufenozid-applications to control a defoliating moth in hyper-diverse oak forests on birds, using autonomous sound recorders in a large replicated full factorial field experiment. Over the period of our three-year study, we found significantly reduced acoustic complexity in early summer during the first two years because of pesticide-application. However, a deeper evaluation showed that this reduction in acoustic complexity was not related to birds, but to a reduction in the caterpillars' chewing sounds. The several year approach showed that the legacy of the pesticide treatment lasted for a second year, but occurred consistently in the same phenological time window. Our study show that continuous measurements of sound diversity are able to identify even cryptic changes in the environment just by acoustic changes. However, the pesticide application did not affect the sound activity of birds as originally expected.

Effects of agri-environmental payments on the diversity and functionality of a semi-natural grassland habitat

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Semi-natural grasslands are among the species-richest European habitats. Their conservation, however, is not granted by the measures included in the European Union Common Agricultural Policy, and often requires specific conservation projects (e.g., LIFE projects). Here we link agri-environmental payments, grazing regimes and the conservation of the habitat composition and forage provisioning service, accounting also for site conditions.

We sampled 98 plots in 19 farms and unmanaged control areas in five regions across Italy and Switzerland, partly included in the LIFE Shep-ForBio project. We assessed habitat conservation state and forage yield and quality and fitted piecewise structural equation models to infer the direct and indirect effects of the payments.

Payments did not affect stocking rates, but increased the evenness of grazing intensity, and, in turn, habitat composition and functions. Site conditions had relevant influence, especially elevation, soil carbonates and slopes. Agri-environmental payments contributed to maintain grazing management and in turn to preserve the habitat biodiversity and functions. However, the effectiveness of payments largely depended on the scale of measures' implementation. Farm-level grazing contracts and periodic field monitoring similar to the activities usually implemented in conservation projects would allow to influence the fine-scale grazing intensity and support a result-oriented approach.

A step back on the conservation of a highly threatened species: opposite signs of recovery on *Pinna nobilis* population from Mar Menor lagoon

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The endemic species *Pinna nobilis* is the most endangered Mediterranean bivalve, facing nearly extinction all over the Mediterranean Sea, hosting its last reservoirs in highly impacted coastal lagoons. Thus, knowledge about the populations' conservation status in these ecosystems is essential. In 2019, the Mar Menor lagoon's population was considered as a highly vulnerable population (Nebot-Colomer et al., 2021) due to several ecological disasters. The present study represents a continuation of the previous work, which aims to evaluate the resilience of the population, by assessing its reproductive capacity and maintenance of population. To do so, between 2019 to 2022, we installed between 23–45 larvae collectors, monitored 7 permanent individual plots, and conducted visual searches and censuses. None of the methodologies carried out detected the incorporation of recruits in the population. Moreover, a decrease in densities was observed, results agreeing with an increase in the number of dead individuals in the permanent plots. Our results pointed out to opposite signs of recovery of the species, increasing its vulnerability to future disturbances. Therefore, urgent management and conservation actions focused on restoring the ecosystem and protecting *P. nobilis* individuals are needed to avoid this population extinction.

Climate warming is linked to insect declines and increases in Switzerland in the last 40 years

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Reports on insect decline have raised considerable concerns in the scientific community and the public. Climate change and land-use change are considered to be main drivers of insect decline, but their combined and interactive effects on insect populations are poorly understood. Studies of adequate temporal, spatial and taxonomic scale are largely missing. We used almost 1.5 million species records to analyze insect occupancy trends (butterflies, grasshoppers, dragonflies) in Switzerland across a period of 40 years (1980–2019). We disentangled main and interactive effects of climate and land-use change on species trends, which was possible because Switzerland can be divided into different climatic regions and along an elevational gradient. Our results show considerable declines but also increases of species occupancies. Changes at regional scale were best explained by climate warming, showing the predominant role of climate change in driving insect community changes in the last 40 years. Land-use change was less strongly linked to species trends, indicating that recent efforts to reduce negative land-use impacts had little large-scale effects. Along with interactive climate and land-use change effects, this shows that further efforts in large-scale land-use management are indispensable to halt biodiversity loss in the coming, further warming century.

Rescue an invisible mammal: Fighting for the highly specialized but extremely threatened subterranean blind mole rats in Central Europe

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Subterranean blind mole rats of Central Europe were once considered as pests, now facing extinction. They have unparalleled taxon diversity within Europe and five endemic chromosomal species can be found even in the Pannonian Basin. These taxa have particularly unfavourable conservation status having only a few small, isolated populations with low population numbers and restricted distribution, many of them facing serious threats. However, the conservation of the populations often difficult, as they are typically located in territories not under protection, rather in places of investment, development, construction or agricultural use. These situations are unusual and difficult to manage for nature conservation authorities. We show the current conservation status of all the endemic species of the Pannonian Basin based on the researches and field data collections of the last 20 years. We also present the challenges caused by the most problematic localities. The conservation efforts made so far, the applied solutions and the lessons we learned might contribute to the successful conservation management of other species or similarly sensitive situations.

Diving into a world of data: Marine and freshwater fishes in zoos and aquariums

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This study investigates species from the five fish classes (Actinopterygii, Elasmobranchii, Holocephali, Myxini, Sarcopterygii) recorded in the Species360 Zoological Information Management System (ZIMS) which provides information on ex-situ populations from over 1,300 zoos and aquariums (Z&A) worldwide. Data from the IUCN Red List, representation in the international trade and general type of use for each species were analysed.

Z&A hold 955,645 individuals of 3177 fish species across 533 member

institutions. Of these species, 10.6% are threatened and seven extinct in the wild. Moreover, 139 species are data deficient, and several hundred species have not yet been assessed by the IUCN Red List. Breeding success has been reported for 3.3 % of those species within the last year.

Species360 institutions hold many heavily traded and species not assessed by IUCN such as the Green Chromis and the Ocellaris Clownfish, with thousands of imports into the EU and US every year. While *A. ocellaris* had 492 births recorded in 2021, no breeding success was reported for *C. viridis* despite a population of over 10 000 individuals held by 104 institutions. By highlighting such discrepancies our study can highlight species in need of ex-situ management and support collection planning.

Impacts of agricultural land use on genetic diversity in generalist and specialist blue-winged butterfly species

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Human-induced land use changes can differentially affect species depending on factors such as habitat preference, dispersal affinity, and specialization. While census size and distribution are important measures of a species response to land use change, these measures do not capture the impacts on genetic diversity and their long-term implications. Here, we examine the genomic effects of agricultural intensification on a pair of blue-winged butterfly species that vary in habitat specialization and mobility. Populations come from sites featuring either a predominance of cropland, production forest, or suitable grassland habitat in the surrounding landscape. When possible, we have sequenced museum specimens collected in the early 20th century from nearby localities to establish historical measures of diversity. We measure nucleotide diversity, heterozygosity, and runs of homozygosity, as well as reconstruct past effective population size changes in these populations to examine how diversity is being impacted by land use changes. We examine population structure to determine if habitat fragmentation is a barrier to gene flow and if it has resulted in increased inbreeding within populations. Combining these results, we aim to determine the differing evolutionary effects land use may have on species with varying life histories and their implications for conservation practice.

Grasslands along linear infrastructure are species-rich but only partly support species of conservation concern

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Grassland habitats along linear infrastructure, such as road verges and power-line corridors, cover vast areas and constitute an opportunity for conservation of species associated with declining semi-natural grasslands. It is however unclear to what extent infrastructure grasslands harbour these species. We surveyed plant, butterfly and bumblebee communities in semi-natural pastures of high nature value, road verges and power-line corridors in 32 landscapes in Sweden. We compared alpha and beta diversity among these habitats, and tested how their area in the landscape contributed to alpha, beta and gamma diversity. The alpha diversity of all three species groups was as high in power-line corridors and verges of small roads as in semi-natural pastures, regardless of landscape composition. Although there were large similarities in the community composition among habitats, there were important differences between infrastructure habitats and semi-natural pastures. Landscapes with power-line corridors had higher plant alpha and gamma diversity than other landscapes, but there was no such effect for butterflies or bumblebees. Novel grasslands along infrastructure cannot replace semi-natural grasslands as habitat for the most specialized grassland plants and insects, but especially in landscapes with low area of semi-natural grasslands they can be important habitats and should be managed to promote biodiversity.

Discovering the role of habitat characteristics on saproxylic insects using a rapid assessment of feeding galleries and boreholes

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Knowledge of habitat characteristics and preferences of saproxylic insects and their response to variation in availability is critical for assessing the ecological impacts of deadwood management. The relationship between deadwood amount and saproxylic insects is evident. Further, many studies report the importance of host species, albeit with contrasting results regarding the degree of specialization, which decreases with increasing deadwood decomposition. Yet, a difference between deciduous and coniferous species is recognized. Habitat diversity, expressed as a variability of deadwood dimension and decomposition, shows a positive influence on insect diversity. However, quantitative studies of species succession along the decomposition process are lacking. We tested a rapid assessment based on feeding galleries and boreholes to investigate habitat characteristics for saproxylic species and the underlying drivers for their occurrence, richness and community composition. We tested factors at different spatial scales that influence the occurrence of individual saproxylic insect families, assessed their influence on family richness, and the community composition. This is one among few studies testing if a rapid assessment method at family-level is appropriate for deriving habitat preferences and thresholds.

Effects of forest fires on the composition of vascular plants and bryophytes in hemiboreal Estonia

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Since forest fires frequency is expected to increase, it is important to understand effects of fires to forest ecosystems. We investigated the impacts of forest fire on understorey vegetation that accounts for a large part of the total plant species richness of forest ecosystems. Our research was carried out in northwestern Estonia, where six different stands dominated by Scots pine (*Pinus sylvestris* L.) were burned 12, 21, 38, 69, 80 and 183 years ago. Effects of time since fire and environmental factors (soil and light variables) on the richness, diversity and cover of vascular plant and bryophyte layers, and on the richness of different species groups were evaluated. Compositional variation was analysed with non-metric multidimensional scaling, Multi-response Permutation Procedures, and Indicator Species Analysis. In vegetation plots, 70 species (31 vascular plant and 39 bryophytes) were found. The cover of the bryophyte and vascular plant layers increased with longer time since fire. There were also compositional differences in the recently burned vs long-time ago burned areas. In conclusion, time since fire impacted compositional patterns of understorey vegetation, although time-related trends in species richness were less evident.

Urban horticulture for biological conservation

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Among threats to global plant diversity, urbanization has been a key driver of species loss and extinction. Trade among urban areas has further fueled the spread of exotic and invasive species, impacting native plant communities globally. New evidence, however, recognizes cities as unexpected repositories of biological diversity. For instance, up to 15% of the global tree flora is estimated to live in the world's cities. Urban areas contain hundreds of species that are considered either extinct in the wild, critically-endangered, endangered,

rare, or vulnerable to extinction. Rather than viewing urban horticulture as a threat to biodiversity, we argue that this practice – alongside the landscape plantings it delivers – have unrealized potential for meaningful plant conservation at large scales. Urban areas have resources, space, technologies and human capacity to sustain plant conservation at the wide scale needed to limit further loss of plant diversity. In this contribution we present a framework and roadmap that seeks a new nature-positive vision for urban horticulture to significantly contribute to the UN's Decade on Ecosystem Restoration (2021–2030) and UN Sustainable Development Goals 11 Sustainable Cities and Communities, and SDG 15 Life on Land.

Understanding the drivers and consequences of global insect biodiversity change

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In recent years, several studies have investigated changes in insect biodiversity. Biodiversity changes are driven primarily by land-use change, and increasingly by climate change, but no study has assessed the effect of these drivers on insect biodiversity globally nor, importantly, the potential for interactions between these drivers. Here, we show that the interaction between rapid historical climate warming and intensive agricultural land use is associated with a reduction of almost 50% in abundance and of 27% in numbers of species within insect assemblages, compared to less-disturbed habitats with lower rates of historical climate warming. These patterns are particularly evident in the tropical realm, whereas some positive responses of biodiversity to climate change are seen in non-tropical regions in natural habitats. Importantly, a high availability of nearby natural habitat often buffered the reductions in insect abundance and richness associated with agricultural land use and rapid climate change, but only in low-intensity agricultural systems. Our results show that insect biodiversity will likely benefit from mitigating climate change, preserving natural habitat within landscapes, and reducing the intensity of agriculture.

Habitat availability explains recent range losses in terrestrial mammals

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The average rate of loss of vertebrates is now up to 1000 times higher than background rates, with mammals being particularly affected by human activities. Broad-scale destruction of natural habitats, in particular tropical forests, is one of the primary sources of species loss. However, the lack of data on species' distribution and fine-scale changes in habitat for the recent past have prevented comprehensive threat assessments. We collected data on the distribution of >450 mammals in the 1970 s–80s that lost at least part of their range in the past 50 years, then we calculated the amount of habitat currently available within the lost and retained portions of the range. We found a net discrepancy between the habitat available in retained areas compared with lost areas, where the latter contained significantly less habitat. This trend was particularly evident in large mammals and in almost all land regions identified by IUCN. Understanding the role of habitat degradation in recent range dynamics and identifying species and areas most affected can help prioritize conservation interventions.

Dutch landscapes are losing insect-pollinated plants

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The interruption of plant–pollinator interactions may threaten global plant diversity, food security, ecosystem stability and human well-being. Recent reports of strong declines of both insects and plants seem to point to insect decline as a driver of plant decline. However, it is still unknown whether these trends are linked and to what extent plant declines are related to insect pollination, as plants often produce seeds without the need for insect pollinators. Here we combine 626,229 Dutch vegetation plot data from 1930 to 2017 and plant traits to show that the proportion of obligately insect pollinated plants has declined ~10.4% while obligately wind pollinated plants have increased ~9.6% over the last 87 years. The proportion of facultatively insect pollinated plants has declined ~6.4% while facultatively wind pollinated plants have increased ~9.6%. This proportional change reflects an absolute decline in the number of insect pollinated species and increase in the number of wind pollinated species over time in the Netherlands. In conclusion, Dutch landscapes are losing insect pollinated plant species, which are being replaced by wind pollinated species. Based on our results, we encourage policies to address the conservation of insect pollinators to mitigate the decline of plants.

Human–Nature Relationships in East Asian Animated Films

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Our relationship with nature is complex and exploring this extends beyond academia. Animated films with powerful narratives can connect humans with nature in ways that science cannot. Narratives can be transformative and shape our opinions. Nevertheless, there is little research into non-Western films with strong conservation themes. Hayao Miyazaki is a Japanese filmmaker that is acknowledged as one of the greatest animated filmmakers and master storytellers globally. The themes of environmentalism, feminism and pacifism resonate throughout his films. His underlying message is that humans must strive to live in harmony with nature, whilst presenting us with the socio-cultural complexities of human–nature relationships. I review five of Miyazaki's films that explore human–nature relationships. One film was released with a special recommendation from the World Wildlife Fund for Nature (WWF) and the other won an Oscar. I explore the lessons that we can learn from these films regarding human–nature relationships, and how to create powerful narratives that resonate with audiences and transcend cultural barriers.

Human disturbance disrupts home range dynamics in a large carnivore.

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Most studies on home range (HR) properties variation have focused on large-time scales. However, individuals often show strong behavioural plasticity, an aspect that cannot be captured without incorporating a dynamic approach, which uses short-time scales, to HR analyses. Human disturbance has been shown to alter animal's spatial behaviour, yet its effects on animal HR dynamics have not been evaluated. Using a brown bear (*Ursus arctos*) population as a biological model, we examined the dynamic HR properties and assessed how they are affected by human disturbances. We estimated HR areas at a daily scale using the 95% T–LoCoH method. Bears exhibited a seasonal pattern in the HR properties. HR size and location varied daily, with the HR being largest and displacing furthest distances during the summer solstice. Females showed more pronounced seasonal patterns than males. Human disturbance disrupted the seasonality of brown bears' HR properties, with females being more affected. We propose the dynamic approach as a more meaningful measure for describing space-use, particularly in species with large spatial requirements. Assessing the seasonal and dynamic nature of the HR may improve our predictions of space-use and the associated behavioural implications for species that have to adapt to the ongoing human expansion.

Time to skip causal claims and to be more transparent in conservation evaluations

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The delivery of rigorous and unbiased evidence on the effects of interventions lies at the heart of the scientific method. We examine scientific papers evaluating agri-environment schemes, the principal instrument to mitigate farmland biodiversity declines worldwide. Despite previous warnings about poor study designs in this field, we found that the majority of studies published between 2008 and 2017 still lack robust study designs required to evaluate intervention effects. Potential sources of bias that arise from the correlative nature of data are rarely mentioned, and results are still promoted by using a causal language. This lack of robust study designs likely results from poor integration of research and policy, while the erroneous use of causal language and an unwillingness to discuss bias may stem from publication pressures. As these violations to the scientific method can have serious repercussions on the general view concerning conservation research we propose some practices to improve scientific reporting and discussion of study limitations in intervention research.

Population genomics of a cephalopod species reflect oceanographic barriers and inbreeding patterns

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Temporal variation of population size and genetic connectivity determine current patterns of genetic diversity within species, and hence their capacity to respond to natural selection. Yet, these demographic processes remain largely unknown in oceanic systems, where many species are still being described and are exploited. Here, we present one of the first population genomic studies in a cephalopod, *Octopus insularis*. Using genomic data, we identify the South Equatorial current as the main barrier to gene flow between southern and northern parts of the species range, followed by discontinuities in the habitat associated with depth. We find that genetic diversity of insular populations significantly decreases after colonization from the continental shelf, also reflecting low habitat availability. We find a stronger population expansion for coastal relative to insular populations, consistent with increases in habitat availability since the Last Glacial Maximum. The direction of gene flow is coincident with currents and eddies between isolated populations. Together, our results show that oceanic currents and habitat breaks are determinant in the diversification of marine species, shaping standing genetic variability within populations. Moreover, our results show that insular populations are particularly vulnerable to current human exploitation and selective pressures, calling the revision of their protection status.

Using eDNA presence/non-detection data to characterize the abiotic and biotic habitat requirements of a rare, elusive amphibian

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The environmental DNA (eDNA) approach has already been established as a valuable tool for the detection and monitoring of rare and elusive species. However, its application is not limited to assessing whether or not a species is present in a given area. In this study, we collected environmental data from 48 aquatic locations that had previously been investigated in an eDNA-based study. We sought to determine the abiotic and biotic factors that could explain the presence or non-detection of Hula painted frog DNA at those locations, in order to characterize this rare species' little studied habitat requirements. We found that the detection probability of this species decreased substantially with increasing phosphorus loads as well as in the presence of the wetland plant *Lythrum salicaria*. By contrast, the

detection probability increased markedly when *Phragmites australis* or *Ludwigia stolonifera* constituted part of the dominant aquatic vegetation. Our results expand the knowledge on this elusive frog species and contribute valuable information for future habitat restoration plans. They further show that eDNA data can also be used to characterize the putative habitats of species where such data are scarce or even totally lacking.

Reclaiming vacant land for green infrastructure to provide ecosystem services

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Urban green spaces provide important habitat and ecosystem services. In post-industrial legacy cities like Cleveland, Ohio (USA), built structures are demolished as people leave these cities, resulting in newly vacant land. Vacant land constitutes an opportunity to establish low-cost green infrastructure (GI) that provides ecosystem services. Our objective was to determine whether investments in GI can support stormwater management and pollinator habitat. 2 GI treatments were implemented in Cleveland, Ohio from 2014 to 2016: rain gardens (low-cost) and bioswales (high-cost). Rain gardens were mulched depressions containing water tolerant forbs. Bioswales were created by constructing channels seeded with a variety of perennials. We hypothesized that investments in low and high-cost GI could enhance local bee biodiversity. Pollinators were sampled for three years (June–August) using bee bowls and yellow sticky card traps. Vegetation variables were also measured. Generalized linear mixed models evaluated if pollinator species varied with treatment, habitat variables, and observation date. Preliminary analyses demonstrate a similar abundance and species richness of pollinators across treatments. Further analyses will examine whether pollinator functional diversity varies with treatment. Our results suggest that GI can improve stormwater management without endangering urban bee biodiversity.

EDGE Zones revisited: spatial priorities for the conservation of tetrapod evolutionary history

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The biodiversity crisis is set to prune the Tree of Life in a way that threatens billions of years of evolutionary history. To secure this heritage along with the benefits it provides to humanity, there is a need to understand where the greatest losses are predicted to occur. We therefore present the first study mapping threatened evolutionary history for all tetrapod groups, globally and within Biodiversity Hotspots, as well as revealing patterns of Evolutionarily Distinct and Globally Endangered (EDGE) tetrapod species. We found that threatened evolutionary history peaks in the Guinean Forests of West Africa, whilst EDGE richness shows high endemism and peaks in Madagascar. We then revisited the EDGE Zone concept for spatially prioritising phylogenetic diversity, using a novel complementarity procedure with uncertainty incorporated for 33,628 tetrapod species. This resulted in 25 priority areas, which are insufficiently protected and disproportionately exposed to high levels of human pressure. Together, they occupy less than 1% of the world's surface but harbour one-third of threatened evolutionary history, half of which is found nowhere else. We believe these EDGE Zones can highlight areas of immediate concern to the researchers, practitioners, policy makers, and communicators looking to safeguard the Tree of Life.

Gender and caregiving influences academic performance of ecologists

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In science, greater dedication leads to higher performance. Consequently, scientists with caregiving responsibilities will suffer downfalls in productivity. Caregivers are mainly women, so their career is highly affected. Based on a self-perception survey among Argentinean ecologists, we studied the distribution of caregiving responsibilities, time use distribution at work, and perception of researchers' own work in relation to gender. We found that a larger percentage of women carry caregiving duties, dedicate less uninterrupted time to work, and more to non-work-related tasks, than their male's counterparts. We found no effect of caregiving on age at promotion, although women tend to start earlier stages of their careers younger than men. Women tend to value their own work more poorly than men. Moreover, the work-family balance is perceived negatively by women in early career stages. We claim that caregiving duties must be considered worldwide when evaluating a researcher's performance, especially for women. Public policies must help relieve women from heavy caregiving tasks and facilitate leaving their home space to detach from not-work-related tasks. Greater peer recognition of women's research should increase their participation as advisers and referents, as well as their own work recognition and that of other women.

Long-term effects of prescribed fire and dead wood manipulations on boreal polypore communities

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Intensive management of boreal forests has resulted in even-aged stands with little dead wood and few natural disturbances such as fire. Since dead wood, both burned and unburned, provides critical habitat for many threatened wood-inhabiting species there is a need for restoration. Here, we report the long-term effects of prescribed fire and coarse woody debris (CWD) additions, on polypore community diversity in spruce dominated boreal forests in Finland. The experiment has a factorial design (n=3) including three levels of created CWD (5, 30 and 60 m³ ha⁻¹) crossed with fire or no fire. In 2018, 16 years after the initiation, we inventoried polypores on 20 logs per stand. We found that overall polypore community composition differed between burned and unburned stands. However, only red-listed species abundances and richness were positively affected by prescribed fire. We found no effects of CWD additions. We concluded that the long-term effects of fire for threatened polypore communities are beneficial. Additionally, our results suggest that although addition of CWD does not influence species diversity per dead wood item, fire does. This demonstrates that fire, besides the well-known effect of increasing habitat amount, may also favour red-listed polypores by changed habitat quality and continuity.

Adapting biodiversity conservation to a warming climate: a synthesis

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It is a challenge to adapt conservation strategies to a changing climate. We systematically compiled recommendations from scientific literature reviews regarding adapting biodiversity conservation to climate change in boreal and temperate regions. Most recommendations belonged to eight dominating categories: (i) Promote both connectivity that facilitates dispersal through landscapes and connectivity that maintains populations within landscapes; (ii) Focus on sites acting as climate refugia, (iii) Protect a few large areas rather than many smaller; (iv) Consider the regional location, especially by locating conservation measures at sites predicted being important in the future; (v) Protect areas also temporarily, as a response to extreme events or changes in range distributions; (vi) Increase habitat diversity over landscapes by protecting many different habitats; (vii) Mitigate habitat deterioration caused by climate change and restore degraded habitats in production landscapes, and (viii) Decrease land use intensity and adapt practices to climate change, for example by increasing the ecological resilience to climatic stresses. Climate change implies that more conservation efforts are required to reach conservation goals. To protect biodiversity, both traditional conservation strategies and strategies adapted to climate change are needed; moreover, novel approaches developed as a response to climate change will become relevant.

Phenological shifts in pear flowering predicted under all future climate scenarios

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Climatic warming has shifted flowering times in multiple plant species. Changes in flowering phenology could have significant implications for ecosystems; impacting pollination services, pest populations and community interactions. Furthermore, there is lack of information on how crop flowering times will react to future climate scenarios. Using 60 years of data from pear (*Pyrus communis* L.) orchards in Kent, UK we explored temporal changes in flowering phenology, identified weather variables driving this change, and predicted how flowering times may be altered with respect to future emissions scenarios. We show pear flowering (1990–2020) in the last 30 years has advanced 11.44 days compared to historical data (1960–1989). Moreover, this shift is apparent in all twelve pear cultivars and four phenological stages analysed. Our results indicate this advancement began after 1982; that air temperature and frost days significantly impact flowering; and this change in phenology is likely to continue under future climate scenarios. Four Representative Concentration Pathways from the UK Climate Projections 2018 report were used to model future climate impacts, under all scenarios a phenological advancement in flowering time was predicted by 2080. Methods used could be easily applied to other plant species, making broader predictions about the impact of climate change.

Disentangling the effects of management, field structure of fallows and surrounding landscape composition to promote steppe bird conservation

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Fallow lands provide a crucial habitat for steppe birds, and their reduction has been related to steppe bird population declines. In north-eastern Spain, a regional conservation measure that promotes

the management of 3000 ha of fallow land has been proven to favour steppe bird populations by increasing the abundance of target species and other farmland birds. Nevertheless, its positive effects are variable within the steppe bird community. This study explores which are the characteristics that make fallow fields successful. We used variance partitioning methods to separate the effects of management (e.g. fallow age) from intrinsic field characteristics (e.g. field size) and landscape composition (e.g. amount of farmland area) on the presence of target species. Fallow management and landscape composition played different roles depending on the studied species. For *Tetrax tetrax* and *Melanocorypha calandra* landscape had the biggest effects, while management was the most important for *Burhinus oedipnemus*. Our results point out the importance of both dimensions when managing fallow fields for steppe bird conservation and highlight the importance of objective driven management. Knowing the keys of successful management at field level and optimal planning at landscape level would help improve the design of targeted conservation plans and future Agri-environment-climate measures.

Understanding the drivers of common bird populations decline in Europe.

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The dynamics of European bird populations have been reported for decades, showing a general decline in bird abundances. However, the direct effect of the main anthropogenic pressures on bird populations remains difficult to identify as pressures may interact at different spatial scales and bird responses may vary between species and be delayed in time. Our objective is to quantify the influence of four widespread anthropogenic pressures (agricultural intensification, change in forest cover, urbanisation and climate change) on the dynamics of bird populations and to identify the traits of the most impacted species. We therefore analyse time-series of 170 common bird species monitored in 28 European countries over 37 years in relation to each of the four pressures. Agricultural intensification appears to be the main negative factor in the decline of most bird populations, while forest cover is associated with a positive effect, urbanisation with a negative effect and species' thermal preference determines the effect of temperature change on each species. Our results rank and quantify the effects of anthropogenic pressures on European common bird population, highlighting the urgent need for transformative changes in agricultural practices, landscape management and climate change mitigation to effectively conserve these populations.

Unpacking links between ad-hoc management and demography in an endangered tropical wild bird

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Current conservation research is insufficiently focused on designing and testing management interventions for species of conservation concern. Due to practical limitations and difficulties of experimenting on endangered populations, testing impacts of conservation interventions is frequently retrospective, and can be confounded by concurrent influences of natural background processes also impacting vital rates.

Here, we use long-term individual-based data on the endangered island endemic Mauritius Fody *Foudia rubra*, to explore the impacts of supplementary feeding on individual productivity. Our information-theoretic approach allows the impacts of this intervention to be separated from natural processes which also influence productivity for both sexes.

We establish that nesting frequently is a key component of individual productivity. We show that supplemental feeding increases productivity across a spatial gradient; individuals who have territories nearer feeding stations are able to nest more frequently than their more distant peers. This impact applies to both sexes, and regardless of mating strategy.

We show that long-term data on endangered species can be used to

test the impact of management, and hence contribute to population recovery; and we recommend that a greater focus on conservation interventions can only be delivered if species recovery programmes invest in long-term monitoring which generates such data.

The potential of flower strips to enhance biocontrol in conventionally managed cereal fields

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The recent decline of semi-natural habitats in European agricultural landscapes has led to a tremendous biodiversity loss. A widespread tool to halt any further decline are agri-environmental measures such as flower strips. To date, the potential beneficial effect of flower strips on ecosystem services such as biocontrol has predominantly been studied in organic farmland, even though the majority of agricultural land is farmed conventionally. We investigated the potential of perennial flower strips (compared to grassy field margins) to enhance spill-over of natural enemies into adjacent conventionally-managed cereal fields. We used cereal tiller counts and D-Vac sampling to quantify aphids, cereal leaf beetles and their natural enemies at increasing distances from each habitat type.

Our results suggest a contrasting effect of habitat type on the two investigated pest species at peak infestation point. However, the ratio of enemies to pest individuals tends to be slightly higher with adjacent flower strips compared to grass strips for both pest species.

We conclude that perennial flower strips have weak beneficial effects on biocontrol at peak infestation, even in conventionally-managed agricultural systems. This effect may vary during the course of infestation. Therefore, we propose that future investigations consider temporal pest-enemy dynamics.

Does regional context influence the effectiveness of Agri-environment Measures in protecting the habitat of farmland birds?

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Agri-environment schemes, ecological focus areas and organic farming are the main tools of the Common Agricultural Policy to counteract the dramatic decline of farmland biodiversity in Europe. However, their effectiveness seems to vary depending on the regional environmental and land-use context. Using ensemble species distribution models and field-level land-use information from the Integrated Administration and Control System, we investigated the effects of five groups of measures (buffer areas, cover crops, extensive grassland management, fallow land and organic farming) on the occurrences of 11 farmland bird species in three study regions in the Czech Republic, Germany and Spain. Despite differences in environmental conditions and land-use context among the three study regions, the majority of species were positively associated with all measures in all regions, except for the German case study, where organic farming had contrasting responses across species. Variable importance scores were low in all regions for all measures compared to climatic, topographic and land-cover variables; and the difference in modelled habitat suitability between scenarios with and without agri-environment measures was limited. We argue that the low uptake of these measures by farmers, despite their overall positive effects on habitat quality, compromises conservation efforts for farmland birds in European agroecosystems.

Understanding the relative impact of different threats to large carnivores in a global deforestation hotspot

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Large carnivore populations are declining globally due to the impacts of multiple threats, particularly habitat destruction and direct persecution. Understanding the relative contributions of different threats to population declines is important to set effective conservation interventions, but for most species, this remains poorly understood. Here, we assess the individual and combined impacts of habitat destruction and persecution on jaguar and puma populations across the 1.1 million km² South American Gran Chaco. We reconstructed species-specific habitat suitability, as well as the spatial footprints of each threat for the period 1985–2020. We then used these data in spatially explicit, individual-based modelling frameworks to analyze population dynamics under different threats. We found that persecution contributed more strongly to population declines of both jaguar and puma than habitat destruction. Furthermore, where both threats interacted, declines were much stronger than for any single threat. Our analyses also uncovered where remaining population sources and sinks for each species are in the Chaco. These results highlight the key areas where threat-specific interventions could effectively contribute to conserving large predator populations across the region. Our study underlines the urgent need for considering multiple threats together to design and implement more effective conservation strategies.

Predator avoidance behaviour of large carabids revealed by non-destructive methods in a managed oak-hornbeam forest

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Animal behaviour can be a good proxy for any habitat alteration and can act as early warning signallers indicating the changes in community structures. The previous radio-tracking underlines the adverse effect of certain forestry treatments on carabid movement and also revealed that there is a no-movement phase in all trajectories. Nonetheless, there is no direct estimation for taxon-specific predation pressure on carabids which can be a proxy for the risk in habitat utilisation, often referred to as an ecological trap. In our study, we explored the predation pressure on carabids using 3D printed decoys installed in two types of forestry treatments, preparation cuts and clear-cuts, and control plots in a Hungarian oak-hornbeam forest. We estimated the seasonal, diurnal and treatment-specific aspects of the predation pressure on carabids as a complementary study of a preceding radio-tracking on the same experimental setup. Our results revealed a significantly higher predation risk in forestry treatments than in the control, especially for nights. In addition, the predator avoidance behaviour based on the non-movement phases in recorded trajectories also revealed the high predation pressure in the treatments. These findings clearly showed that a modified forest

environment can shift ecological interactions between species.

Multi-Action Conservation Planning across realms: A Mixed Integer Programming Model approach

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Spatial connectivity is essential when planning effective conservation, especially for species that depend on different realms during their life cycle. Traditionally, most of efforts have focused on working on different realms independently, overlooking the propagation of threats across realms, the cumulative impacts of threats or tackled the problem using heuristic optimization models.

We present a mathematical programming model that identifies priority areas for the implementation of management actions for multiple threats across four realms (terrestrial, freshwater, estuary, and marine) to benefit multiple species simultaneously. We use the Tagus River (Iberian Peninsula) as a case study, where we integrate three different types of connectivity: longitudinal along rivers, and multidimensional in the estuary and marine realms. We simulate the propagation of threats across the study area using four types decay functions: two exponential decays (medium and high), one linear, and no decay. We then compare the allocation of management actions under two alternative scenarios: multi-realm planning vs single-realm planning. The results show that the multi-realm planning outperforms the single-realm, especially for species that depend on multiple realms and that the greater the propagation of threats, the larger the differences between scenarios. This model could help better address complex conservation management problems elsewhere.

ARE WE SPECTATORS, CURATORS, OR CARETAKERS? NATURALNESS AND APPLYING PRINCIPLISM TO CONSERVATION

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The concept of 'Naturalness' in conservation remains polysemic. Some believe ecosystem naturalness is the extent of freedom from anthropogenic influence (autonomy), others contend that naturalness should be determined by structure (integrity). A pristine ecosystem is both autonomous and has 100% integrity. The problem begins when needing to decide how to treat an impacted ecosystem. The autonomy school advocates hands-off, the integrity school promotes benchmark-based restoration by active management. Alternatively, expected global changes suggest enhancement of ecosystem resilience should be prioritized. I argue that integrity, autonomy, and resilience are all morally valid. Their incompatibility can be tolerated if we recognize that: (a) full naturalness is an unattainable abstraction to strive for; (b) restoration processes are not an act of curation but rather a „contrary-to-duty“ obligation; and (c) integrity, resilience, and autonomy are mid-level moral principles of applied ethics. Mid-level principles are 'Prima facie' and are used to construct a working protocol responsive both to the case details and high-level principles. The principles may conflict, and are prioritized based on existing conditions. Ecosystem conservation mid-level principles should include: (1) minimize anthropogenic footprint; (2) manage for integrity based on a reliable and feasible benchmark; (3) enhance future resilience to projected global change.

Long-term changes in insect diversity under moderate human activity in a UNESCO biosphere reserve

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In general, conservation practices are based on historical records of species distribution which do not extend further back than 200 years. Palaeoecology can be used as a tool to explore baselines further back in time, to create a better understanding of the history of different species. This research focuses on the foothills of the High Tatra Mountains in Slovakia, part of the Tatra Transboundary UNESCO reserve. A 1000-year high-resolution record of subfossil beetles (Coleoptera) was extracted from peat sediment, and changes in species composition and diversity were counted by identifying fossils to genus, or species level. By comparing the fossil beetle record with a fossil pollen record for vegetation, interactions between the local insect fauna and surrounding landscape were reconstructed. Significant declines in insect diversity occur from AD 1600 and are partially related to a continuous desiccation of the peat bog. These changes coincide with increased human activity in the region. Our results challenge the assumption of the High Tatra Mountains as a largely pristine environment and the focus on saproxylic beetles for nature protection of mountain areas in central Europe.

The Birds@Farmland Initiative: enhancing farmland bird conservation by the CAP

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The Birds@Farmland Initiative is a conservation effort, aiming at improving the weak performance of the CAP in relation to farmland birds by increasing number, diversity, volume, uptake and effectiveness of farmland bird conservation schemes. For this purpose, we selected ten EU Member States (MS), i.e. Austria, Bulgaria, Czech Republic, Finland, France, Germany, Hungary, Italy, Portugal, and Spain, and defined the most relevant ten agricultural systems and fifteen farmland bird species. In each of the ten MS, demand for conservation schemes for these systems and birds was assessed based on published evidence and stakeholder consultations. Based on this assessment, 22 conservation schemes (4 in Portugal, 2 in each of the other nine MS) were co-developed with relevant stakeholders (e.g. authorities, farmers associations, NGOs, academia) with the aim to get them considered by the National Strategic Plans for the CAP that were submitted to the European Commission by December 2022. The developed conservation schemes dealt e.g. with crop rotation, extensive grasslands, field margins, grazing intensity, mixed farming systems, rice cultivations, steppe habitats, and the particular species corncrake, great bustard, grey partridge, lapwing, and Montagu's harrier. Indeed, several of the developed schemes were taken up into CAP Strategic Plans (related negotiations are ongoing).

Fungal diversity monitoring through the air? – a case study on a waxcap grassland

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Fungi are indispensable for most ecosystems, but strikingly little is known about their diversity, distribution and consequently about their threat status and extinction risk. This is partly owed to the fact that fungi are difficult to monitor. Therefore, we evaluated the use of eDNA analysis of airborne spores to aid in the revision of the fungal

red list of Switzerland. We collected spores on a species-rich waxcap grassland site using three different methods and analysed their genetic composition with metabarcoding. In parallel, all fruitbodies from typical grassland genera were located. The spore samples were highly diverse and contained many macrofungi with a previously evaluated conservation status. We found that threatened and data deficient categories were underrepresented compared to non-threatened categories. Precipitation had a strong influence on species composition for sampling methods that also collected rainwater. Spore analysis detected 18 of 30 locally occurring grassland species, and 17 additional putative species from the selected genera. Modelling of spore dispersal provided evidence for rapidly decreasing spore concentrations already within a few meters distance from the source fruitbodies. We conclude that spore sampling is able to capture the surrounding local diversity and contributes valuable insights in the distribution and abundance of fungi.

Urban fire salamander monitoring – a race against the plague

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The invasive *Batrachochytrium salamandrivorans* (Bsal) chytrid fungus rapidly eats its way through fire salamander (*Salamandra salamandra*) populations in Europe. However, monitoring is particularly lacking in southern Germany. This master's thesis examines a population in an urban forest in Tuebingen, Baden-Wuerttemberg, that was healthy and estimated at over 600 individuals at the beginning of this millennium. Standard larvae removal sampling and non-invasive nocturnal larval counting methods are compared in population size estimation. Furthermore, a capture-recapture approach of the (semi-) adult, terrestrial salamanders using the individual black and yellow pattern repeats the population count from 2005. Recapturing an individual from that study would confirm an impressive age for these small amphibians, that are tested for Bsal at this opportunity. Furthermore, due to the urgent monitoring needs, an implementation of the fire salamander to a citizen-science pattern recognition project is envisioned. These approaches provide valuable information on the southern expansion of the salamander plague which might provide a solution to save this charismatic species.

Monitoring costs for result-based payments: Will remote sensing technologies be the game-changer?

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Paying landowners for conservation results rather than paying for the measures intended to provide such results is a promising approach for biodiversity conservation. However, a key roadblock for the widespread implementation of such result-based payment schemes are the frequent difficulties to monitor target species for whose presence a landowner is supposed to receive a remuneration. Until recently, the only conceivable monitoring approach would be conventional monitoring techniques, by which qualified experts investigate the presence of target species on-site. With the rise of remote sensing technologies, in particular increased capabilities and decreased costs of unmanned aerial vehicles (UAVs), technological monitoring opportunities enter the scene. We analyse the costs of monitoring an ecological target of a hypothetical result-based payments scheme and compare the monitoring cost between conventional monitoring and UAV-assisted monitoring. We identify the underlying cost structure and cost components of both monitoring approaches and use a scenario analysis to identify the influence of factors like UAV costs, area, and monitoring frequency. We then estimate future cost developments considering equipment, analysis and labour costs. We find that although conventional monitoring is the cost-effective monitoring approach today, future cost developments are likely to render UAV-assisted monitoring more cost-effective.

Does urban wild food foraging create negative ecological impacts? A mixed-methods study in Vienna, Austria

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Urban wild food foraging can enhance health and well-being of urban residents and educate them about food, nutrition and biodiversity conservation. However, public authorities in charge of managing public urban green spaces tend to be sceptical about potential negative ecological impacts of foraging on urban plant populations. We conducted a mixed-methods study in Vienna, Austria, to understand whether this scepticism can be shown to have an empirical basis. First, we conducted twenty-one semi-structured expert interviews with urban foraging stakeholders and then 458 structured interviews with Viennese residents. Stakeholders reported that many urban foragers apply a range of practices that prevent and limit negative ecological impacts. The predominant share of Viennese foragers indeed had good knowledge about foraging with care. However, foraging rare species and inconsiderate foraging in foraging hotspots by some foragers can still be problematic. These findings suggest that, in Vienna, a general scepticism towards foraging is unjustified. However, monitoring of foraging activities and targeted information to raise awareness about good foraging practices are needed. If this is done, public authorities can use urban foraging to strengthen urban residents' interaction with nature, and to educate them about biodiversity conservation.

Novel neonicotinoid-like insecticides and food stress: synergistic threat for wild bee pollinators? – Evidence from laboratory and semi-field experiments

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Wild bee pollinators in agricultural landscapes are threatened by various – potentially interacting – stressors, including exposure to pesticides and loss of floral food resources. Since the recent partial ban of neonicotinoid insecticides, novel alternatives such as sulfoxaflor and flupyradifurone are increasingly used. Potential negative effects of field-realistic exposure to these new insecticides and their interactive effects with commonly co-applied fungicides or food stress on solitary wild bees remain largely unknown. We investigated the impacts of sulfoxaflor and flupyradifurone, as well as their interactions with the common fungicide azoxystrobin and food stress, on the solitary bee *Osmia bicornis* under laboratory and semi-field conditions. Pre-flowering application of sulfoxaflor, alone or combined with the fungicide, did not have significant negative effects on fitness under semi-field conditions. Application of flupyradifurone during crop flowering and food stress, however, caused pronounced synergistic negative impacts on survival, reproduction and foraging behaviour. Under laboratory conditions, worst-case field-realistic doses of both insecticides negatively affected developing *O. bicornis* bees. Our results highlight the need for improving pesticide risk assessment schemes by considering interactions with further stressors in order to better protect bees and their invaluable pollination services.

Using butterflies as a bioindicator for pollinator communities

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Monitoring population trends is essential for conservation, but long-term high-intensity monitoring is required to reliably calculate trends. Consequently, we have poor understanding of insect population trends, except for butterflies. Butterfly diversity is considered indicative for other pollinators' diversity such as bees or hoverflies, but this has never been tested. We sampled 42 of the Dutch butterfly

association monitoring sites during April–August 2020 and recorded species richness and abundance of butterflies, bees and hoverflies, and flower cover and richness. Using the same methods, we sampled one site in Spain for six years. To test whether pollinators with similar functional traits show similar trends, we categorized bees and butterflies according to their diet breadth, larval resources nitrogen-affinity and body size. Only hoverfly richness was correlated with both butterflies ($R^2 = 0.05$) and bees ($R^2 = 0.14$), and may be more suitable as a bioindicator of pollinator diversity. Abundance of all three groups showed no significant correlation, except for non-polyphagous species. Despite the weak correlation among pollinators, all groups were highly affected by flower richness, yet, they respond to different host plant families. Monitoring schemes aiming at pollinator conservation should also monitor habitat quality and vegetation resources as bioindicators for multi-taxa pollinator diversity.

Predicting mammal occupancy in tropical protected areas from species characteristics: a pantropical analysis

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The structure of forest mammal communities appears surprisingly consistent across the tropics, presumably due to convergent evolution in similar environments. We do not yet know whether this consistency extends to mammal occupancy, and this is particularly the case when assessing habitat specialization. Here we ask whether species characteristics predict occupancy patterns and, if so, whether these relationships are consistent across biogeographic regions. We assessed how feeding guild, body mass and ecological specialization relate to mammal occupancy in protected areas across the tropics. We used standardized camera-trap data (1,002 camera-trap locations and 10 years) and a hierarchical Bayesian occupancy model. Herbivores consistently had the highest occupancy. However, only in the Neotropics did we detect a significant effect of mass on occupancy: large mammals had lower occupancy than medium-size mammals. Importantly, habitat specialists generally had a higher occupancy than generalists, though this was reversed in the Indo-Malayan sites. We conclude that considering habitat specialization is key to understanding variation in mammal occupancy across regions, and that protected areas may be crucial for increasing specialist occupancy. However, this is not the case in the Indo-Malayan region, where specialists had the lowest occupancy, likely reflecting the higher anthropogenic pressure that protected areas experience there.

Translating agro-ecological approaches from one region to another – the importance of context-based solutions and multi-sector knowledge exchange.

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Agro-ecological approaches to enhance beneficial insects is increasingly being adopted in agriculture systems to support both biodiversity conservation and sustainable production. Interventions to enhance pollinator communities or natural enemies of crop pests are well studied, and form an integral part of agri-environmental schemes, particularly across Europe and North America. However, implementing such interventions in small holder farming systems without policy support, poses specific challenges, particularly when there is a dearth of collated local evidence or knowledge, further compounded by

a lack of financial incentives for implementation. Here we present case studies from two projects in Tamil Nadu, India, funded through the Global Challenges Research Fund. 1. Finding the right floral interventions to enhance pollinator communities in Moringa fields – a crop of economic importance and an emerging „superfood“ and 2. Enhancing beneficial insects and natural enemy populations in the border of rice paddy fields for improved pest control. Both case studies are founded on effective knowledge exchange and interactions with local small holder communities, to co-develop context specific solutions that can enhance their livelihoods. Our projects provide a conservation evidence narrative of how established research approaches can be modified and successfully translated into an ODA context.

Evidence of quadratic effects of traffic volume on roadkill probability

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Wildlife–vehicle collisions are considered the predominant direct negative effect exerted by roads on many species. The probability of roadkill is affected by the level of traffic volume, and theory suggests that the effect should be unimodal. However, empirical evidence of this theory is lacking. We studied the effects of traffic volume on roadkill probability for 20 species in Israel using nation-wide data, encompassing 2846 road km, while controlling for the effects of road attributes, landscape features, and species abundance (using habitat suitability as a proxy). The unimodal effect was empirically supported for the striped hyena and gray wolf. A quadratic U-shaped effect was identified for six other species. We suggest that the U-shaped effect is caused by intra-species variability in road avoidance behavior, which may be related to high tolerance of anthropogenic disturbances, causing reduced avoidance of high traffic roads. Our research shows that high mortality rates occur at all levels of traffic volume, and that low traffic roads pose a major risk of mortality for many species. These insights, together with the gleaned effects of road attributes (e.g., lighting, median separation, verge vegetation) on roadkill probability are valuable for reducing wildlife–vehicle collisions, contributing to road safety and nature conservation.

Species habitat suitability increased during COVID19 lock-downs

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COVID19 lock-downs had a strong effect on the environment and biodiversity. The most visual effect was the occurrence of wildlife in the middle of urban settlements. However, the true effects on species is not well known. Our questions are: Were lock-downs long enough to increase habitat suitability? Which is the temporal lag for detecting significant habitat suitability improvements? Here, we applied a recent developed framework to analyse trends on species' habitat suitability over time by modelling the species distributions with temporal series of environmental variables obtained from satellite remote sensing. We analysed the trends on habitat suitability for several species of vascular plants, amphibians, reptiles, birds, and mammals, before, during, and after the first lock-down in Portugal and Spain, from 01/12/2019 a 31/08/2020. We modelled the species distribution with Maxent presence-background algorithm. We obtained five environmental variables (Albedo, Evapotranspiration, LST, NDVI, and Surface reflectance) from MODIS with periodicity of 8 days. We analysed the habitat suitability trends with the Mann-Kendall test. Preliminary results show an increment on habitat suitability around March of 2020, approximately at the middle of the lock-down, with a subsequence decrease, for most of the species.

Economic growth and extinction threat of short-ranged species

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The heightened rate of global biodiversity loss is both alarming and well documented. Several drivers are clear (e.g., habitat loss, harvesting, climate change), but there remains debate about how income growth contributes to biodiversity loss. While popular theories (e.g., Environmental Kuznets Curve and Ecological Modernization) have environmental damage increase with income at early stages of development, green growth posits that economic growth may reduce environmental damage once a certain threshold level of wealth is reached. This paper explores how socioeconomic variables relate to regional variation in the endangerment and population trends of small-ranged species using a subsample of the IUNC Red List of Threatened Species assessments of 3,508 species. Regression analysis suggests no indication of an Environmental Kuznets Curve for biodiversity loss. Rather, GDP per capita is negatively associated with both species endangerment and decreasing population trends. This negative association between per capita income and species threat is estimated over a sample of largely low-income regions, and opposite to the positive partial correlation found for the larger IUCN sample. Taken together, the results suggest the inverse of an Environmental Kuznets Curve and that possibilities for green growth may be limited to low-income regions.

An overlooked type of the long-distance dispersal of plants: The trade of commercial potting substrates

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Humanity intentionally spreads several species, accompanied by other plant species dispersed accidentally. Although the global trade of horticultural plants and substrates may disperse large quantities of propagules, it has hardly been studied from an ecological point of view. We studied the viable seed content of potting substrates to assess (i) the seed content and composition of substrates, (ii) the effect of substrate composition on seed content, and (iii) whether there are common characteristics of the dispersed species. We found 438 seedlings of 66 taxa and found that 1 litre of substrate contains an average of 13.27 seeds of 6.24 species. Seed content of the substrates was highly variable and substrates containing manure contained a substantially higher number of species and seeds than substrates without manure, indicating that this pathway is an interplay between endozoochory and accidental human-vectored dispersal. Our results demonstrate that potting substrates can disperse large quantities of seeds of a wide range of species over large distances. We conclude that this kind long-distance dispersal may have complex effects on plant populations and communities; however, as this dispersal pathway is largely understudied and has hardly been considered as a type of LDD, its ecological and conservational consequences are unknown.

A tool for the Ethical Assessment of the application of Assisted Reproduction Technologies (ART) in conservation.

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Assisted Reproduction Technologies (ART) are a powerful tool for wildlife conservation, yet little attention is paid to their ethical evaluation. ART, however, pose ethical challenges related to animal welfare, safety of the people involved, quality of the procedures, and preservation of the biomaterial of endangered species. Lack of attention to the ethical assessment of the application of ART can compromise the acceptability of conservation projects with otherwise commendable goals. Here, we present an ethical self-assessment tool (ETHAS) designed for mammalian conservation breeding programs employing ART. ETHAS is designed from current regulations, veterinary and lab-

oratory best practices, and scientific literature, and it is iteratively improved by experts in the fields. It consists of customizable checklists adaptable to the different ART procedures employed in conservation and used to assess their specific applications. It is currently employed in the complex efforts for conserving the Northern White Rhino (*Ceratotherium simum cottoni*), which make use of different ART, including transrectal ovum pick-up, in vitro fertilization via intracytoplasmic sperm injection, and embryo transfer. After briefly describing the tool, we present the results of its application. Consistent application of ETHAS helped to keep procedures under scrutiny, identify critical issues, and improve communication among partners.

Mapping socio-political networks as a tool to manage human-carnivore interactions

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Increasing evidence from around the world points to the need for landscape-level governance for large carnivores' conservation. This expands the spectrum to other inter-connected governance institutions, for ex. agriculture, tourism, rural development, etc. who need to collaborate with conservation institutions to create effective governance solutions. However, due to competing and segregated objectives, human-human conflict hampers effective governance of large carnivores in multi-use landscapes. Therefore, effective collaborations through networking between different institutions (formal and informal) has been recommended. Although it has a huge potential, the dynamics of each institutional system, coupled with the complexity of scales and hierarchies, implies that achieving one in reality is challenging. In our study, we identify challenges in governance of carnivore conservation by interviewing experts from inter-connected institutions in India and Germany. Based on existing literature, and case studies on social networks in socio-political-ecological systems, we develop a framework that aims to map existing networks of governance and informal actors (such as stakeholders), with their motivation and interests, at different scales and levels of functionality of inter-connected institutions. This framework will be able to provide information on the power dynamics and collaborations, and identify possible points of intervention to generate better measures for an effective governance.

Looking for some shade? The importance of rocks compared to vegetation as a thermoregulatory refuge for desert lizards

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The availability of cool microhabitats in the desert is limited but critical for the ability of ectothermic species to perform behavioural thermoregulation. Although most studies focus on vegetation cover as a thermal shelter, we still lack a deep understanding of the importance of other microhabitats for thermoregulation, especially in hot and dry deserts where vegetation is scarce. We measured the preferred body temperature of lizards and recorded temperatures offered by different bushes and rocks of various sizes and we developed a biophysical model that simulates a thermoregulating lizard and calculates the percentage of microhabitat usage. Our empirical data suggest that large and medium rocks offer much cooler temperatures than bushes (by 9 °C) and that the open microhabitat, bushes, and small rocks, are often too warm for lizards. Moreover, our simulation predicted that lizards should spend most of their activity time under medium and large rocks (~35%) than under bushes (~4%) or in the open (~25%), suggesting that rocks have a critical role as a refuge from high temperatures during the summer. Our research sheds light on the importance of medium-to-large rocks as an ecological resource, which may provide many animals protection from the extreme temperatures of the desert.

Butterfly functional diversity is not only determined by grassland type, but also by the presence of management and landscape context

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Degradation and disappearance of semi-natural habitats became a global conservation problem. Our study aims were to explore the complex processes that affect butterfly functional diversity and functional community composition in less productive and threatened grasslands. We examined the functional characteristics of butterfly communities with three contrasting design factors: habitat type (calcareous grassland vs. orchard meadow), management (managed vs. abandoned), and landscape context (forested vs. agricultural landscape). We surveyed butterflies of 20 calcareous grasslands and 20 orchard meadows in Central Germany. To test the effects of our design variables, we selected six functional traits (overwintering, voltinism, wing length, diet, flight period, territoriality) for each butterfly species, and we assigned values to them from the literature. Our results showed that habitat type had the strongest filtering effect on butterfly functional traits of the three design variables. Functional diversity indices, such as functional richness and divergence values, were higher in calcareous grasslands than in orchard meadows. We found that calcareous grasslands are characterised by butterflies having more specialist traits, which were moderated by the presence of management and landscape context. Therefore, to maintain the threatened butterfly fauna of calcareous grasslands, extensive management should focus on calcareous grasslands in forested landscapes.

Urbanization decreases species richness of soil invertebrates but increases their abundance until climate gets wetter: a meta-analysis

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Soil invertebrates are important decomposers, but urbanization modifies soils heavily too. There are several contradicting results and theories in the literature on how urbanization affects soil invertebrates. Therefore, the main question of our research was to investigate how urbanization affects soil fauna, and how this is influenced by annual precipitation or mean annual temperature. We performed a systematic review using the Web of Science and Scopus databases (103 papers) and then performed a meta-analysis. Abundance showed an increasing trend, whereas species richness decreased significantly with urbanization, implying biotic homogenization. Abundance of Myriapoda and Isopoda increased significantly with urbanization. This is probably due to adaptation of some generalist species to urban conditions resulting in population increases. Species richness in general showed a negative trend, which was significant for Collembola, Annelida and Gastropoda. Most likely these animals are sensitive to soil compaction associated with urbanization. Mean temperature had no effect, but precipitation significantly modified the effects of urbanization on density. In drier regions, urbanization increases soil moisture because of irrigation, which can cause population increases. In humid regions, the urban environment is drier compared to surroundings leading to population decreases. Thus, as discussed above, climatic variations significantly affect the impact of urbanization.

Developing the first result based agri-environmental scheme in Hungary: a case study from the Órség National Park

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Several studies revealed that action based agri-environmental schemes are ineffective in preserving biodiversity. Result based payments offer a possible solution by exactly defining the objectives of the subsidy and allowing farmers to choose their own approach to meet them. In the Contracts2.0 project, we started to develop a result based scheme in the Órség National Park, Hungary with the participation of local stakeholders and experts. Grasslands were chosen as the broader biodiversity target, and then it was narrowed down to species-rich hay meadows. Conservation objectives were identified in terms of species composition and diversity, structural diversity and the availability of nectar sources for pollinators. To measure the results of the management, 21 positive and 8 negative indicator species and two indicators for species composition and 6 for habitat structure were selected. Indicators were tested in the field in 7 selected meadows, partly with the participation of the farmer. Our preliminary results show that (i) plants are more reliable indicators than butterflies, (ii) farmers are willing and capable to measure indicators and (iii) the values of most indicators are in correlation with plant and butterfly species richness measured by more intensive methods in the same fields.

Is land sparing or land sharing better for the conservation of disturbance-dependent species?

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Large-scale disturbances like fire or grazing by herbivores are often suppressed or absent in production landscapes. Conservation of species adapted to these disturbances require maintenance or reintroduction of disturbances, which can be achieved through land sparing or land sharing approaches. Land sparing implies that disturbances occur in protected areas, and land sharing that they occur within the production system. We compared the benefits of these approaches for fire in forests and grazing or mowing in semi-natural grasslands. We reviewed empirical studies comparing the outcome of disturbances in protected and non-protected areas, as well as information from Swedish authorities and companies responsible for governing and implementing disturbances in protected and non-protected areas. We found that for several aspects a land-sparing approach is better: the temporal continuity as well as the method and intensity of disturbances, and the post-disturbance treatment. However, land sharing may be more cost-efficient, and increase the spatial extent of disturbances. Together, this suggests that combining land sparing and land sharing in multifunctional landscapes is most effective for preserving disturbance-dependent species. Such an approach emphasize consideration of the location, protection status and disturbance regime of areas across landscapes, and demands cooperation across administrative levels.

Effects of logging intensity on species and functional composition in the national park „Fruška gora“

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Conservation of forests in Serbia almost entirely relies on protected areas where biodiversity preservation and wood production are simultaneous goals. The real outcomes of this strategy, however, are still under question. The present work examined the ecological

impacts of logging in the national park “Fruška gora”. We analysed whether and how plant species and functional composition varies with gradient of logging intensity over the period of 20 years. Spatial and temporal changes in forest cover were analyzed by means of remote sensing techniques. Functional composition maps were generated through up-scaling of in situ data on functional traits of dominant tree species. Logging intensity gradient was obtained through forest canopy density model. Linear mixed models were used to analyse the influence of logging intensity on functional composition. Results show intensification of logging in the national park from 1994 to 2015, with effect on changes in functional composition. Significant effect occurred when forest canopy density lowered from > 65% to 50–65%. Functional composition changed towards species with more acquisitive traits, largely driven by expansion of more competitive species *Tilia tomentosa*. We argue that current management practice in forest protected areas may not be supportive of conservation goals.

The role of socio-economic factors in range filling of European alien mammals

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Biological invasions are amongst the main drivers of biodiversity change and decline; despite increasing efforts, the spread of invasive species continues unabated. We present an analysis on propagule pressure (introduction effort) for 71 alien mammal species in Europe, whereby we predicted each species' range size based on points of introduction, dispersal distance, generation length, and residence time. We then calculated the filling ratio for each species (observed/predicted range size) and used it as a response variable in a generalized mixed model, to quantify the effect of a wide array of event-, species-, and location-level predictors on filling ratio. Predictors included, among others, propagule pressure, points of introduction, human footprint index, and climate matching.

We found that many alien mammals' predicted ranges were significantly broader than their observed ranges, suggesting that environmental or biotic factors may limit species' spread. Nonetheless, we found that propagule pressure and pathway of introduction played a major role in determining alien mammals' range sizes. Both factors ultimately depend on human behaviour rather than species or environmental characteristics. Our results indicate that alien mammals' distribution in Europe is largely shaped by anthropogenic activities, confirming that preventing future introductions is key to limit further alien species' spread.

Noise pollution from wind turbines and its effects on wildlife: a cross-national review of current policies and planning regulations

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The quest for cleaner energy has caused governments to expand renewable energy infrastructure, including the proliferation of wind turbines. However, wind turbines (WTs) can also pose a risk to certain wildlife species, with research predominantly focusing on the potential harm caused to birds and bats from impact injuries. New evidence suggests that WT noise (WTN) impacts on wildlife can be detrimental, but rarely receive attention from planners and scientists. Potential types of impact include damage to wildlife physical wellbeing, vital survival mechanisms, social and reproductive processes, and habitat continuity. The current study examined the planning guidelines relating to WTN and wildlife in three locales where WT infrastructure is being expanded: California, USA, Germany, and Israel. Findings indicate that none of them have clear zoning limitations or even obligatory environmental impact assessment (EIA) guidelines that require addressing the specific issue of WTN effects on wildlife. However, some steps taken by planning authorities suggest a potential for improvement. These include language in California planning recommendations addressing the potential effects of WTN on wildlife; a German survey of local bird species' sensitivity to noise (including a WTN section); and increasing recommendations in Israel and Germany that encourage distancing WT from protected areas.

Body size response to local and global climate variables, a case study on reptiles from southern Danube Delta Biosphere Reserve

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Reduction in body size in response to global warming has been widely documented under experimental conditions. However, it is uncertain whether the response extends to wild populations, as it varies across different taxa and is influenced by other variables. We used a data set collected over the span of 16 years (2006–2021), on body sizes (i.e., body length and body mass) of one tortoise and three snake species from southern Danube Delta Biosphere Reserve, Romania. The aim of the study was to examine whether body size changed over time and which climate variables can explain the variation. The results showed a significant increase over time in body length of *Dolichophis caspius* and *Natrix tessellata*, while for *Testudo graeca* it was a statistically nonsignificant increase. Body mass significantly increased over time only in *D. caspius* and *T. graeca*. Decrease in body mass was explained by an increase of temperature only in the two *Natrix* species, while a decrease in body length only in *Natrix natrix*. Overall, our results suggest that climate warming affects body sizes in reptiles differently and does not support the hypothesis that declining body size as a response to warming is a universal response.

Plant diversity and the conservation role of three indigenous agroforestry systems of South-eastern Rift- valley Landscapes, Ethiopia

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Woody and non-woody tree/shrub species conservation is one of the ecosystem services provided by agroforestry (AF) systems across the agricultural landscapes. The study was aimed to investigate plant species diversity, structure, and composition of three AF systems. Twenty farms were randomly selected, and vegetation inventory was employed in a 10×10 m farm plot. A total of 52 perennial woody and enset species belonging to 30 families were recorded. Of all species identified, 63.5% were native and two species were registered as endemic. The highest proportion of native species was recorded in Enset based (93.3%) and the least was in Coffee-Fruit tree-Enset based (59%). According to IUCN Red Lists and local criteria, 13 species were recorded as of interest for conservation in all AF systems. *Prunus africana* was identified as both vulnerable by IUCN Red Lists and rare for 25% of species that least occurred. In terms of diversity and richness Coffee-Fruit tree-Enset based AF systems were significantly different from the two remaining systems. However, the species abundance and evenness did not show significant difference. In general, owning higher number of species under AF systems of the present study showed a good potential to serve as a heaven for biodiversity conservation.

New Evidence on the Linkage of Population Trends and Species Traits to Long-Term Niche Changes

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Despite the assessment of long-term niche dynamics could provide crucial information for investigating species responses to environmental changes, it is a poorly investigated topic in ecology. We present a case study of multi-species niche analysis for 71 common

breeding birds in Northern Italy, exploring long-term niche changes from 1992 to 2017 and their relationship with both population trends and species traits. We (i) quantified the realized Grinnellian niche in the environmental space, (ii) compared variations in niche breadth and centroid, (iii) tested niche divergence and conservatism through equivalency and similarity tests, (iv) calculated niche temporal overlap, expansion and unfilling indices, and (v) investigated their association with both population changes and species traits. Results supported niche divergence (equivalency test) for 32% of species, although two-thirds were not supported by the similarity test. We detected a general tendency to adjust the niche centroids towards warmer thermal conditions. Increasing populations were positively correlated with niche expansion, while negatively correlated with niche overlap, albeit at the limit of the significance threshold. We found moderate evidence for a non-random association between niche changes and species traits, especially for body size, clutch size, number of broods per year, inhabited landscape type, and migration strategy.

Avoiding the trade-off between carbon gain and water loss in tree-based climate mitigation.

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Tree planting campaigns are spreading globally to mitigate climate change by sequestering carbon. Afforestation, however, can have adverse effects in formerly open landscapes, including the loss of native biodiversity and water shortage. Here we assessed the strength of the trade-off between tree cover and water loss on contrasting soil types in temperate semiarid regions. With an intensive, year-round monitoring of soil moisture, we found that forests on sand retain topsoil moisture throughout the year but below this a thick dry layer develops during the vegetation period, which gets filled up to field capacity only in the winter, hindering groundwater recharge. Grasslands on the other hand have drier topsoil throughout the vegetation period due to direct insolation but the moisture reserves below are not affected and allow deep percolation. In contrast, deep soil desiccation has not been encountered in the forests of cohesive soils. Topsoil heavily dries out in the grasslands of cohesive soil, so the water balance seems to be more negative in them. We conclude that in flat semi-arid areas, where landscape-wide water regime depends on deep percolation, sandy soils should be avoided for afforestation, while the trade-off between water and carbon is not so severe on cohesive soils.

DNA barcoding provides new insights into the drivers of earthworm species diversity in old Swedish grasslands

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Old semi-natural grasslands are important for plant conservation in Sweden, but it is uncertain if they also benefit belowground biodiversity, such as earthworms. Traditional methods for earthworm species determination make use of morphological characteristics and therefore fail to determine juveniles that still lack certain morphological features and cryptic species that are morphologically similar. In this study, we describe the earthworm diversity, species composition and densities, determined by species barcoding, in 28 old semi-natural grasslands in Uppland, Sweden. We also characterize the drivers of earthworm community composition in these grasslands, by linking environmental variables to species densities using joint species distribution modelling. The environmental variables determined for each grassland include vegetation (diversity, plant functional group coverages, vegetation height), soil properties (texture, SOC, total N, total P, pH), management (fertilization, grazing intensity) and landscape heterogeneity around sampling locations.

We specifically ask the following questions: 1) Does DNA barcoding reveal patterns that are undetectable with traditional determination

methods, such as higher species richness or differing patterns in adult and juvenile densities within a species? 2) Which environmental parameters best explain earthworm species richness and diversity in old grasslands? 3) Do earthworm species and ecological groups respond differently to environmental parameters?

Genetic diversity of wild olives in Greece: a diverse resource in danger of erosion

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The genetic diversity of wild olive (*Olea europaea* subsp. *europaea* var. *europaea*) populations in the Mediterranean is endangered primarily due to the expansion of olive groves. In this study the genetic relationships between Greek wild olive populations sampled in nature and Greek cultivars originating from reference collections, were investigated. A total of 209 wild samples and 67 cultivar samples including all officially recognized Greek cultivars were analyzed by employing 10 microsatellite loci. Wild populations exhibited high levels of genetic diversity, while 39% of the number of alleles detected was found only in the wild germplasm. Inbreeding was observed within populations, probably as a consequence of their fragmented spatial distribution. Three gene pools of wild olive were revealed corresponding to the geographical areas of: Northeastern Greece, Peloponnese-Crete, and Epirus. Most cultivars clustered in a separate group, while the rest of them formed a heterogeneous group with membership coefficients akin to the three wild olive clusters. Furthermore, bidirectional gene flow was detected between populations of Peloponnese-Crete and one cultivar gene pool. Ex situ conservation and in situ protection in areas isolated from cultivar gene flow is proposed for the preservation of this diverse resource.

Harmonising forest management terms and definitions for effective biodiversity studies

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A myriad of forest management definitions are used in scientific literature. Their inconsistent use within biodiversity-oriented investigations hampers result comparability, and impedes conclusions on the effects of forest management on biodiversity. By using a bottom-up approach we provide shared definitions of silvicultural and management terms to be used in forest multi-taxon biodiversity studies. We collected and synthesised information of forest management deriving from the publications of 29 multi-taxon studies across Europe backing the COST Action "BOTTOMS-UP". We asked the researchers involved to enter their management and silvicultural data in a standardised format. The results highlight the strengths and weaknesses

of the terminology used in the selected studies. While data on forest stand biomass are frequently reported, information on the silvicultural regime is often lacking or fragmentary. We found broad and heterogeneous definitions of the silvicultural system and forest vegetation classifications. We propose a common framework of definitions and forest management data to be recorded with the aim of increasing the comparability of multi-taxon forest diversity studies. This work helps in bridging the gap between practice and science in the field of sustainable forest management.

Nature through the AI lens: questioning how scientists shape individual's experience of natural environments in algorithm-driven citizen sciences

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Automatic species identification algorithms are increasingly common in citizen science programs in ecology. They complement or replace active individual experiments previously done with identification keys or books. Yet, this mediation by artificial intelligence raises questions about the individual experience of using these tools compared to a traditional naturalist experience that implies a more extensive embodied and cognitive commitment. It also raises the question of the environmental knowledge acquired and the eco-citizen involvement that can result from it.

In this qualitative study, we interviewed 20 scientists in charge of or having taken part in a citizen science program involving these algorithm-driven identification tools. We asked them about the process of creating their programs, their motivations for using these algorithms, and their thoughts on how they created the experience for their participants.

An inductive content analysis allows us to highlight that the interviewees have envisioned several ways of individual empowerment through participation in these programs, in the way individuals acquire environmental knowledge, make the tools their own and use them in their eco-citizen implication. We also highlight significant differences in perception regarding the stakes and perspectives of the use of AI in the short and long term in these programs involving citizens.

Species wished to protect: poor convergence between knowledgeable farmers and conservationists

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Both professional conservation, and communities with traditional knowledge of landscape management protect animal species, although not with the same purpose and not the same species.

We investigated which animal species do the local traditional ecological knowledge holders and conservational rangers consider important to protect, which species are common and different between the two lists, and which are the key features when they include certain species in the list.

Our research was conducted in Slovenia and Hungary, in two neighbouring protected areas. In the two landscapes, we conducted 20+20 structured interviews with local knowledgeable traditional farmers and 20 with conservationists.

Conservationists mentioned the conservation of only slightly more taxa than farmers. The most frequently mentioned taxa differed significantly, but there was also a one-third overlap between the two lists. Birds were more while invertebrates were less represented in farmers' lists than in conservationists'. The rangers had previously thought that profit motive and conspicuous appearance were the main factors in conservation by locals, although species knowledge, morphology and emotional involvement were actually the main factors.

Different knowledge systems focus on the protection of different species. Communication between these knowledge systems and understanding each other's motivations are essential for effective conservation.

Using spatiotemporal models to understand the drivers of fires regimes and impact of anti-deforestation policies in the Brazilian Amazon

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While ambitious environmental policies have decreased deforestation rates in the Brazilian Amazon over the 2005–2015 period, wildfires remain common in the region and led to pervasive forest degradation and associated carbon emissions. The authors developed a spatiotemporal model using Bayesian inferences for assessing the drivers of fire regimes in the State of Pará for the period 2006–2020. Agricultural land use, ranching, deforestation and rural settlements supporting the agrarian reforms were the most prominent drivers of fire regimes. While indigenous land and integrally protected areas (IUCN categories I to III) strongly inhibit fire occurrence, sustainable use areas (IUCN categories IV to VI) slightly favour fire occurrence. Among other inhibitory effects were the percentage of rainforest cover, the intensity of law enforcement efforts, budget to institutions charged with environmental protection, and also the intensity of beef ranching plausibly because of the higher asset value of agricultural land. Results suggest that maintaining a large tract of indigenous land and integrally protected areas, and supporting local landholders switch towards more intensive and less fire-dependant agricultural systems, are essential for reducing forest degradation in the Brazilian Amazon.

Landscape type and floral resources modify plant–pollinator network structure and stability: implications for pathogen exchange

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Pollinators face multiple, potentially interacting threats from human activities. The Biodiversa VOODOO project (<https://voodoo-project.eu/>) seeks to understand how landscape–use, through its impact on floral resources, affects plant–pollinator communities and the transmission of viruses between pollinator species. We present initial results to show how the architecture of plant–pollinator networks varies among agricultural, habitat mosaic, and urban landscapes, with consequences for co-extinctions. We show how modification of floral resources can affect network structure to shape interspecific transmission of viral pathogens and we provide early results that show how niche overlap among species governs the degree of viral pathogen sharing among wild and managed bees.

Quantifying ecosystem services and disservices derived from biodiversity in cacao agroforestry: Socio–ecological opportunities for smallholder farming

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Animals provide crucial ecosystem services such as pollination and pest control in cacao agroforests, but also disservices. Yet, the combined contribution of animal groups to cacao yield, and the trophic interactions that drive them, remain poorly understood. An accurate quantification of biodiversity–driven (dis–)services in cacao helps to identify key management strategies that maximize smallholder benefits. We used a full-factorial experiment to exclude flying insects, birds, bats, ants and squirrels from cacao trees in Peruvian agroforests. We quantified the contribution of each animal group to cacao

fruit set and crop yield and monitored arthropod populations simultaneously. Flying insects, as well as birds and bats contributed to a significant increase in cacao fruit set. Notably, cacao crop yield increased by 114% in the presence of birds and bats, which translates in gains of USD \$497/ha/year for smallholders. Ants and aphids, but no other arthropods, were negatively associated to cacao yield. Finally, we identified a large disservice from squirrels, leading to losses of USD \$84/ha/year.

Our results show an unprecedentedly high contribution of birds and bats to cacao yield. We also warn that these benefits may be undermined by disservices from other animals and discuss the relevance of wildlife–friendly management of cacao agroforests.

Assessing the contribution of cities to regional biodiversity – insights from a large–scale systematic bird survey across urban, rural, and natural areas

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Urbanization is a major driver of biodiversity decline globally, but a growing body of research indicates that cities can retain considerable biodiversity. Therefore, we still lack an understanding of the relationship between urban biodiversity and the regional species pool, which is needed for planning cities that optimize contribution to nature conservation. In this study, we carried out an extensive bird point–count survey across a 300 km² region in Israel, including a major metropolitan area comprising 12 municipalities, and adjacent agricultural and natural land. Nearly 2,200 points were surveyed, randomly located across the region, in a variety of urban and non–urban habitats. Each point was visited twice during the spring season of 2021. Overall, the species pool of urban and non–urban areas in the region was surprisingly similar, with an 80% overlap. Mean local species richness and diversity were similar in urban and non–urban points as well, but these indices differed between species groups (e.g., migrant, non–native, and rare). Turnover among non–urban points was higher than among urban points, both spatially and temporally. Our results suggest that cities are not necessarily species–poor, with a considerable representation of the regional species pool, but community composition is more homogenized, compared to non–urban areas.

How to grow pulses as a means to enhance biodiversity and ecosystem services in rainfed annual farming systems in the Mediterranean? A meta–analysis.

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Legumes get increasing awareness as multi–talents in sustainable agri–food systems. Even in Mediterranean regions, their share on arable land is very low due to the specialisation on cash crops. Knowledge and recommendations for growing pulses considering non–market outputs in alternative cropping systems are scarce. To this end, we synthesized the empirical evidence about the effects of different sustainable management practices on on–field biodiversity (OFD), soil quality (SQ) and yield (Y) in alternative pulse–based cropping systems in Mediterranean climate areas. We conducted a systematic literature review and quantified the impact of alternative management practices and biophysical moderators on ES output using meta–analysis methods. We found significant positive impacts of organic farming on OFD, no–till on SQ and diversified rotations on Y. In multi–service trials, no–till tended to be synergistic for both, Y and SQ. Also, our models showed significant influence of soil pH on OFD, soil texture on OFD and Y, and row spacing on Y and SQ. In conclusion, elements of organic and conservation agriculture seem promising techniques for service–enhancing pulse management; But empirical evidence about different alternative pulse practices and multi–service studies, especially with focus on OFD, are still scarce and yet too few to deduce concrete growing recommendations.

Could forest restoration initiatives hinder rather than help biodiversity loss and climate change mitigation?

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Reversing trends in forest degradation and deforestation is essential for tackling climate change and preventing ecosystem service and biodiversity decline: critical if the Sustainable Development Goals are to be met. Political support for forest restoration at global, regional and national levels is high, but set against a backdrop of continued demand for cultivated land and ongoing deforestation. There is a risk that meeting nationally-determined restoration targets could displace land demand to active deforestation frontiers, generating net biodiversity and carbon losses. Focussing on Colombia, a country that hosts 10% of global biodiversity, we use the spatial partial-equilibrium model GLOBIOM to ask whether restoration targets (1 million ha by 2030) could be achieved in congruence with increasing demand for agricultural, bioenergy and wood products. We also project forest cover change using a probabilistic model based on historic biophysical, demographic, market and non-market drivers of land cover change. Contrasting these results suggests that while there is substantial space for forest restoration to occur on degraded pastureland without displacing market demand for agriculture to forest frontiers, land use change drivers such as conflict, illicit crops and land speculation that are not captured in market-focussed models might determine success in generating net benefits from restoration.

Cost-effective biodiversity conservation under climate change: land purchase versus conservation contracts

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Under climate change, current conservation efforts may become less effective and cost-effective as the effectiveness and costs of conservation sites and measures may change. Flexible conservation policy instruments that allow for the adaptation of conservation measures ("local flexibility") and sites ("spatial flexibility") may improve the cost-effectiveness of conservation under climate change. However, trade-offs between local and spatial flexibility may exist depending on the policy instrument. Here, we analyse land purchase and long-term individual conservation contracts. We develop a model that integrates ecological, economic and climate data and considers the different degrees of flexibility of the two policy instruments. We apply the model to the conservation of the large marsh grasshopper (*Stethophyma grossum*) on agricultural grasslands in a case study area (parts of Schleswig-Holstein, Northern Germany) and consider climate scenarios RCP4.5 and RCP8.5 for the periods 2020–2039 and 2060–2079. In the case study, land purchase has a higher cost-effectiveness than conservation contracts if the conservation agency is able to generate profits from extensive land use. Local flexibility only plays a small role, but spatial flexibility is important when the available budget is small and only allows for small extensions of the conservation network to adapt to climate change.

Nesting behavior drives contrasting responses of wild bee communities to management and local conditions in vineyards

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Viticulture on steep slopes has shaped both landscape and biodiversity in wine growing regions. However, viticultural area suffered strong declines in recent decades due to insufficient profitability. A solution to reduce further abandonment and maintain cultivation economically viable could be vineyard terracing. However, little is known about the effects of vineyard abandonment and a change of vineyard management type on biodiversity.

We determined the effects of vineyard management types in contrast to vineyard fallows, local conditions and the surrounding landscape on wild bee diversity in 45 study sites along the Upper Middle Rhine Valley in Germany. Alongside the Rhine environmental conditions altered slightly i.e. soil shifted from fertile loess to schistose soils which in turn was correlated with increased vineyard abandonment. Although floral resources were higher in managed vineyards, overall wild bee species richness was highest in vineyard fallows. Ground-nesting bees decreased alongside the Rhine with altering site, especially soil conditions irrespective of vineyard types. In contrast, above-ground nesting bees showed stronger responses to vineyard management and were more closely associated with vineyard fallows. Our results show that suitable nesting conditions rather than floral resources structured wild bee communities. Therefore, conservation efforts need to consider both foraging and nesting requirements.

"Show me the money!": Poor reporting of costs of conservation interventions hampers ability to prioritize funds for nature.

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Wildlife conservation is severely limited by funding. Therefore, to maximize biodiversity outcomes, assessing financial costs of interventions is as important as assessing effectiveness. We reviewed the reporting of costs in studies testing the effectiveness of conservation interventions and find very low levels of cost reporting (8.8% of studies reported total costs). Even fewer studies broke down these totals into constituent costs, making it difficult to assess the relevance of costs to different contexts. We investigate trends in reporting by geography and type of intervention to see if some areas of conservation may be better. Without standardized, transparent information on costs, we risk misallocating conservation resources on suboptimal, or at worst ineffective, action. Yet our research is also highlighting the importance of financial costs and benefits in decision-making. I will finish by discussing opportunities for conservationists to improve future practice through encouraging systematic reporting and collation of intervention costs, using economic evaluation tools, and increasing understanding and skills in finance and economics.

Biodiversity and the resilience of nature's benefits to people: a case study of pollination and pest management in South Africa

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Anthropogenic pressures are leading to shifts in community composition, which can lead to declines in ecosystem functioning and impact the benefits that nature provides for people. One major question within this ongoing biodiversity crisis is how resilient are ecosystem services to these community shifts? We combined species distribution modelling, Bayesian networks, and risk assessment approaches

to investigate the potential impact of climate and land-use change on two key ecosystem services in South Africa: pollination and pest control. By incorporating multiple methods, we were able to include the impacts of abiotic drivers and biotic interactions on species distributions, as well as account for species' differing contributions towards ecosystem services. Our results show that future changes to climate and land use have the potential to significantly influence the capacity of ecological communities to provide pollination and pest control, with impacts differing across scenarios and space. We also demonstrate that incorporating biotic interactions is key to understanding species range shifts and the provision of ecosystem services. Our study presents an important step forward in our understanding of how resilient ecosystem services are to species turnover, which is crucial if we are to conserve biodiversity and ecosystem functioning under future environmental changes.

Wildlife behavioral responses to anthropogenic disturbances around natural water sources in the desert

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In desert ecosystems, water is a critically limiting factor for both wildlife and humans, which can result in human-wildlife conflict. We examined the effects of human disturbance at desert water sources on medium-large mammals and birds. We placed motion-activated camera traps around ten natural water sources along a gradient of desert tourism from high to low pressure. We found that human disturbance reduced both species richness and abundance at the water sources. Furthermore, next to the highly disturbed water sources there was little overlap between the activity times of humans and other mammals, with mammals arriving before or after humans' activity hours. Interestingly, the mammal's activity at a distance of ~500 m from the water source showed a similar pattern, even though there were no humans at these sites. At sites where human disturbance was low, there was a much greater overlap between humans' and mammals' activity times. This suggests that the impact of high disturbance next to desert water sources on mammals' behavior extends way beyond the water-source itself.

Birds and intensive fruit production in Brazilian Caatinga: how farming changes bird communities and what impact this could have for production?

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There is no hiding from the fact that much of the world's food is produced unsustainably and agricultural expansion threatens many species with extinction. To bend the biodiversity loss curve, we need evidence-based solutions that help us conserve species, whilst promoting sustainable and fruitful production. Here, we take a closer look at the bird communities within intensive fruit farms in one of the most diverse but understudied dry tropical forest regions of the world, Caatinga in North-eastern Brazil. This region has been undergoing rapid agricultural expansion and intensification, largely producing fresh fruit for export to global markets. Whilst this has improved local livelihoods, what price is biodiversity paying? We present an analysis of bird communities monitored over two years in and around intensive grape and mango farms in the states of Bahia and Pernambuco. We explore how farming impacts these bird communities and identify winners and losers from agricultural expansion at field scale. We consider how the altered bird communities may affect production and how evidence-informed farm practices could be used to promote species beneficial for production and help manage those that come into conflict with farmers.

Validation of the MAES-HU forest condition assessment with fine scale data

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The examination of biodiversity at the multiscale level requires too many resources, so proxy indicators from other (e.g. forestry) databases are commonly applied. Considering the spatial scale and methodological differences, the appropriate application of indicators from different monitoring systems may be questionable without indicator validation. The results of the MAES-HU forest condition assessment (based on the Hungarian NFD – National Forestry Database) were compared with finer scale data. We applied the MAES-HU scoring system on the fine-scale database and we validated some MAES-HU indicators. The MAES-HU scoring was similar to the fine-scale score results in the case of tree species composition indicators, however, it was different for structural indicators. The NFD contains averaged values with sub-compartments as spatial units, which resulted in discrepancies in the structural indicators. This highlights the potential loss of important conservation-related information. We suggest integrating some key conservation indicators into NFD monitoring, so the involvement of other databases becomes unnecessary. The validation of structural indicators showed that old and large-diameter trees indicate more xylophil microhabitats and the presence of large-diameter standing dead trees. Our study highlights that applying indicators as proxies requires the full knowledge of monitoring methods and validated indicator-indicandum relationships.

Conservation and public participation in IUCN's ecosystem governance

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This presentation not only introduces principles of conservation and participation as understood in the IUCN's ecosystem governance theory, but also offers the first glance on the results of the currently finished research on prioritization of conservation in integrated environmental solutions and related decision-making processes. Although the ecosystem governance theory has been gradually developed within IUCN since 2015, it has gained more significant traction in the past three years. In the 2020 research, participation and conservation were identified as two of the six ecosystem governance principles. Although listed separately, their inherent interconnectivity and inseparability makes them one of the cornerstones of the ecosystem governance theory. Since ecosystem governance is about the processes which eventually (should) lead to an on-site management practice, we asked, among other questions, stakeholders in coastal areas how they wish to be represented in environmental decision-making (contrasting with how they are represented now), and examined tendencies within regional and local decision-making with respect to conservation priorities. Results are presented here.

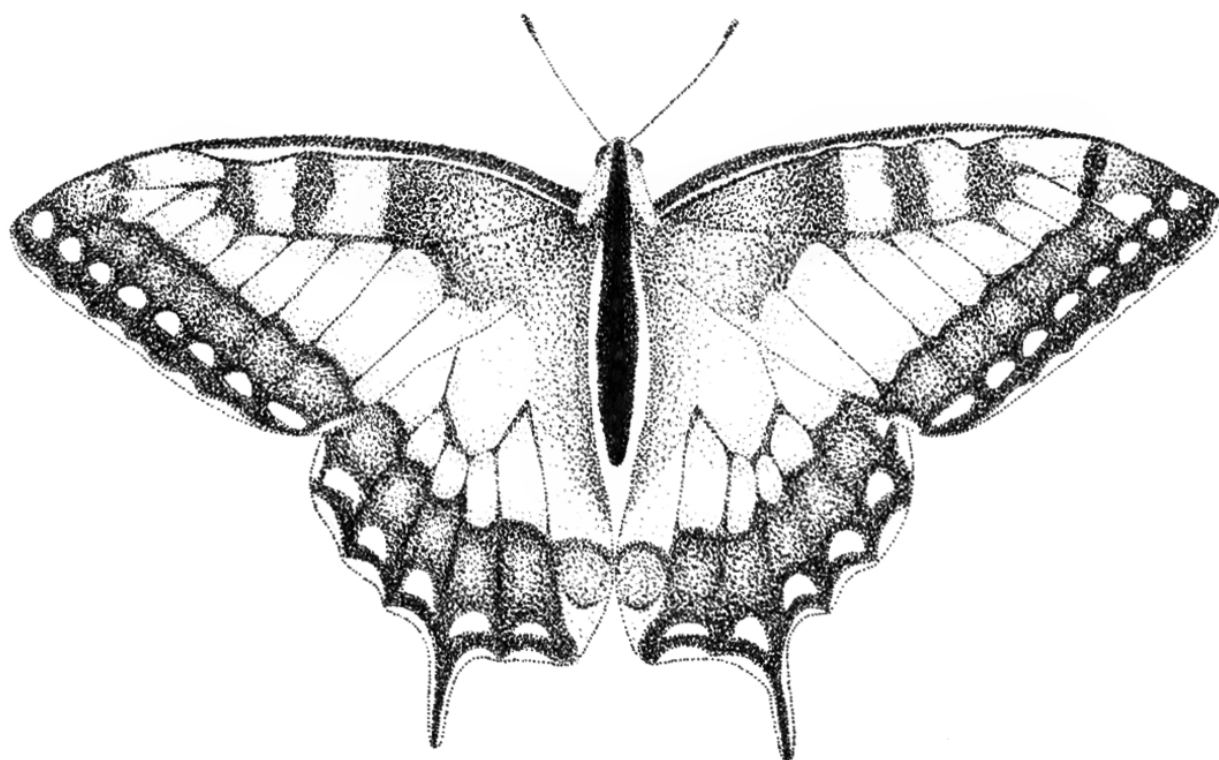
How does climate change influence the pressures on Austria's threatened species and habitats?

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Biodiversity is currently being lost at an accelerated pace. Climate change has emerged as novel direct pressure, but it also indirectly affects species and habitats by modifying other pressures. To understand climate-related changes of the pressure structure acting on threatened species and habitats, experts assigned pressures from a pre-compiled non-hierarchical list of 221 pressures to 1109 species and 57 habitat types. We conducted a literature review on overall trends triggered by climate change. Experts then evaluated whether these trends will cause specific pressures to increase, decrease or remain unaltered during climate change. In a similar procedure, managers of five protected areas analysed 10 characteristic species or habitat types of their areas applying the same methodology. Agricultural pressures are currently affecting 597 out of 1109 species (54%), followed by climate change (direct effects, 354 species, 32%). Hydrological pressures (216 species), energy production (115 species), aliens (71 species) and forestry pressures (259 species) will become substantially more pronounced during climate change, whereas pressures from mixed-source pollution (352 species) will become alleviated in the transformation towards non-fossil energies and electric propulsion. Assessment by conservation managers provided a similar ranking of pressures and measures despite being restricted to selected conservation targets and protected areas.

Abstracts of speed presentation



Graphics by: Sarah Maršíková
Papilio machaon, Linné

Exploring links between local knowledge, values and livelihoods in the land–sea interface: Insights on emerging tradeoffs and change in fisher communities

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Diversification of livelihoods is a strategy to build adaptive capacity but may also negatively affect the transmission of local knowledge and values. Diversification and mobility of livelihoods in land–sea interface is relevant for communities to decrease vulnerability. How people relate to and manage nature based on knowledge and values matter for responses and adaptation to change as well as innovation and identification of new pathways. Here we assess the links between local knowledge, values and livelihoods in order to identify emerging tradeoffs associated to actors and communities' livelihood responses to change. Using semi-structured interviews, we assessed knowledge and values associated with terrestrial and marine species and diversity of income sources, in six communities in Chile. We probed the relationships between income source diversification and human–nature relationships, classified as relational, intrinsic, and instrumental, and discuss implications for place-based adaptation and transformation. Our findings indicate that there are communities losing knowledge and values when they expand their income sources and communities that do not. Certain livelihood diversification may result in time limitations that can impact knowledge transmission. Thereby, we discuss the implications for transformative change that may allow for protection and development of local knowledge and values despite the livelihood diversification.

Social information alters the effect of habitat fragmentation on bird diversity and its stability

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Habitat fragmentation is considered to be one of the greatest threats to biodiversity of our time. However, there are few studies addressing how the different biodiversity metrics (namely – taxonomic, phylogenetic and functional diversity) react to the habitat fragmentation when comparing one to another, and how the impact of habitat fragmentation on biodiversity could be mediated by the social public information. Our goal was to examine how the biodiversity metrics of bird communities in forest patches change with the increasing isolation of those patches, and how those changes could be mediated by manipulating social information. To answer that, we have inspected over 150 forest patches in Central Europe. For each bird community inhabiting a given patch, measures of phylogenetic and functional diversity were calculated. After that we have conducted a large scale behavioral landscape experiment, where we have broadcasted a different types of social information on those stands. Different measures of diversity reacted in a different way to changes in the parameters describing habitat patch fragmentation. Social information was able to mediate the effects of patch size and isolation. Our research helps to understand the importance of individual patches of forest habitats in the farmland for the preservation of biodiversity.

How does Citizen Science help in monitoring protected neglected species?

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Species and habitats listed in the EU Habitats Directive (HD) have not been widely targeted by citizen science projects even though these species require major monitoring and conservation efforts. The use of volunteers could increase the amount of distributional data on these target species, resulting in a better definition of the species conservation status as required by HD national reports. Results from InNat, a 6-years citizen science initiative (born under the LIFE MIPP project and continued under Italian National fundings), targeting protected neglected species and habitats, are presented here. This initiative has involved more than 1.400 volunteers, gathering over 6.000 records. The potential of citizen science for the monitoring of protected species and habitats is here addressed: analyses show a yearly increment of volunteers and records as well as a growth of spatial data coverage for the target species. In this context, the distributional pattern of the records for the given period has been investigated, focusing on the influence of different factors (e.g., proximity to infrastructures or protected areas, human population density).

Wood-inhabiting fungi in rocky pine forests in the High Coast Region in Sweden

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The amount of old growth forests has dramatically decreased during the last century. Many threatened species such as saproxylic fungi, are connected to forests with long continuity and old-growth characteristics. Open rocky pine forests in northeast Sweden are examples of forests with low human impact and old-growth characteristics. Abundance and richness of wood-inhabiting fungi in rocky pine forests was investigated in eight study sites. In addition, we specifically studied the presence of five red-listed species using species specific primers. The fruitbody inventory yielded 48 species in total, including the red-listed species, *Cinereomyces lenis* and *Hyphodontia halonata*. Additionally, four red-listed species, *Antrodia infirma*, *A. albobrunnea*, *Crustoderma corneum* and *Anomoporia kamtschatica* was found with species specific primers. We found no relationship between species and dead wood characteristics. Red-listed species were found on a variety of log types, indicating that every piece of dead wood can be of high importance in these unique low productive habitats and that extraction of dead wood should be avoided as much as possible

Influence of organic farming on the ecological resilience of plant communities to drought

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Studying the impact of farming practices on the resilience of biodiversity to extreme climatic events is key to design sustainable farming systems in a changing climate. However, longitudinal studies monitoring the response and recovery of biodiversity to extreme climatic disturbance such as droughts are lacking in real-world farms. Here, we monitored 10 organic and 9 conventional farms over a period of 5 years covering an extreme drought event in 2018. We surveyed in-field flowering plant communities over the years (in cereals, leys and semi-natural grasslands). We expected that organic farming would promote resilience against drought due to higher levels of pre-drought plant diversity and practices promoting water holding capacity of soils, due to higher soil organic matter. We detected a decrease in plant species richness of 34% and 24% in leys and semi-natural grasslands respectively during the drought compared to the previous year, while species richness remained stable in cereals. Rare plant species were more likely to be lost than common (abundant) species. Organic farming did not affect the loss of plant species relatively to pre-drought levels of species richness. Practices such as soil tillage, not bound to organic management, might drive plant species loss to a higher extent.

From Endangered Plant Species Conservation to Use Conflict Management: an Application of Volunteered Geographic Information in Wetland Protected Area Management

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Many wetland protected areas systems worldwide have a dual statutory mandate both to provide for visitor enjoyment and for the conservation of natural or cultural heritage. Therefore, the distribution of tourists is a critical component of visitor management in wetland protected areas. Gaomei Wetland, a wildlife protected area are not only famous for the largest of the salt marsh habitat of tuberous bulrush grass-*Bolboschoenus planiculmis* in Taiwan, but is also one of the favorite tourism destinations to visit in Taiwan. In order to release the conflicts between trail overuse and endangered plant species conservation in wetland, the effects toward tourist distribution should be discussed. In this study, the Flickr platform was captured the data of Volunteered Geographic Information (VGI). There were a total of 544 visitor spatial position and 9,907 geographic coordinates recorded from 2006 to 2016. It serves to manage visitor distributions in relation to park infrastructure and landscape features. In order to provide the relevant management unit for tourism planning and create a model of protected areas reference, this study attempts to establish a map in conjunction with VGI information and demonstrates the application of visitor management to respond the need of protected area in wetland resources management.

The absolute value of genetic diversity in the genomic era

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Genetic diversity is widely used to understand general processes in evolutionary biology. When applied in biodiversity monitoring and conservation, its absolute value can be converted into risk of extinction. In the context of food production, including agriculture, animal farming and fisheries, low levels of genetic diversity are seen as associated with a higher risk of food insecurity because of e.g. higher susceptibility to disease. Most studies to date have assessed genetic diversity in different species by using a small number of molecular markers (mitochondrial loci and microsatellites) and, more recently, SNP panels. Direct comparisons between such studies are challenging because of ascertainment bias, differences in the sampling design, and variation caused by the specific evolutionary history of the markers, which does not always reflect the overall history of the population/species. Using whole genome sequencing data can potentially provide a platform for unbiased results allowing for comparisons across independent studies. However, the varying quality and availability of genome assemblies across the tree of life requires careful bioinformatics filtering of both assemblies and resequencing data for reproducible results. Here I will discuss the impact of different filtering strategies on the assessment of genetic diversity using whole genome data of non-model organisms.

The influence of traffic and flowering plant diversity on the movements and mortality of flower-visiting insects along roads

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Targeted management of road verges has a great potential to benefit biodiversity, but there is growing concern that road verges can act as ecological traps for pollinators. Roads and road verges also have the potential to influence the movements of flower-visiting insects by acting as barriers or corridors. We selected 10 pairs of road verges differing in the number of flowering plant species (rich vs poor) and a gradient in traffic intensity. Here, we explored the movements of flower-visiting insects by marking flowers with fluorescent dye, and observed the behaviour and mortality risk of bumblebee queens. Road verges were corridors for flower-visiting insects, and roads were barriers to movement independent of traffic intensity. Insects

avoided crossing the road more frequently when there was a higher density of flowers in the road verge, indicating that flower-rich road verges could decrease the mortality risk. For bumblebee queens, the mortality risk dramatically increased with increasing traffic independent of the flower density in the road verge. Our study suggests that the role of road verges as barriers and ecological traps for flower-visiting insects depends on their behaviour, and could be modified by adapting the road verge management.

UAV-Based Wildlife Survey: Methodology and Ethical Considerations

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Unmanned Aerial Vehicles (UAV) equipped with image sensors can be an effective tool for large animal surveys depending on species and the environment in which it is used. A range of research in the last decade focused on the application of UAVs as a survey tool for wildlife. Most discuss the methodology focus on the flight path and image acquisition setup and have a single species of interest.

The lack of research on the development of a best practice and standard operating procedure when using UAVs for the survey of wildlife, resulted in gaps, not only when this method is used, however, also on a national and regional legislation level.

Secondly, limited research was done on the ethical use of UAVs for wildlife census and surveys. The cases where ethics was discussed in this research are usually focused on a single species and in most cases fail to address the environmental impact associated and the effect on non-targeted species that coexist in the same area. This lack of research results in unclear legislation on national level with a general question on minimum standards and ethical considerations when these techniques are used.

FRAMEwork – Experiences from the first year of the Czech Farmer Cluster to improve biodiversity in the agricultural landscape

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FRAMEwork is a H2020 funded transdisciplinary research project (2020–2025) that builds on the UK Farmer Cluster (FC) approach to increase agrobiodiversity across Europe. Eleven FCs have been established as part of FRAMEwork; one of them in southern Moravia. However, this was not an easy task. To identify potential farmers willing to support establishment of a FC, the research team worked closely with AMPI (Association of Local Food Initiatives) and met with a diversity of farmers in different geographical locations. Despite being supportive of the FC idea, establishment of a FC in southern Moravia seems to have been achievable only due to the following: (1) some farmers already had established business relationships, and (2) perceived synergies between the FC approach and the farmers' long-term goals regarding their farms. Further, building on the reputation and trust of a well-established organic farmer, who is now leading the FC, nine farmers, who manage 3,000 ha, could be recruited into the FC. Facilitated by a part-time professional advisor, the FC has collectively progressed ideas on how to improve agrobiodiversity in their landscape. A first project to support kestrels and barn owls is being implemented and a monitoring system established with professionals and the wider public.

Assessing the assemblage level impacts of micropollutants on stream-dwelling fishes in an urbanized area

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High quantity of drugs and other personal health care products emitted to natural surface waters through the municipal wastewater treatment plants. The effect of this diverse mixture of compounds on the living organisms occurring these habitats is completely unknown. Our main goal was therefore to assess this potential effect on the level of fish assemblage. For this, all permanent watercourses of the Budapest (Hungary) metropolitan area were surveyed (altogether 64 sites). Fish assemblage composition and parallel environmental variables (landscape and local scale), water quality parameters and drug residuals were determined. Fish were caught at 40 sites, therefore further analyses were carried out using this filtered database. Additional filtering, regarding the drug residuals has been made: compounds with minimal (<10 ng/l) concentration or frequency of occurrence (<3 sites) were excluded. Data analyses were based on ordination techniques, variable selection and variation partitioning. Significant effect of five, mostly psychoactive drug residuals were identified by the variable selection. Relative effectiveness of the different background variables was determined, which called the attention on the high potential importance of drug residuals in the fish assemblage composition of urbanized areas.

Interspecific competition between mice and voles induced by ad libitum food resources: a simulation of climate change effects on sympatric species?

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How resources are partitioned among sympatric species is conditional to extrinsic (e.g. climate driven) and intrinsic (e.g. demography-dependent) factors. To analyse these effects, we carried out a treatment-control experiment with supplemental ad libitum food accessible to the community of wild rodents, throughout seasons at two latitudinal extremes. We intensively live-trapped woodland rodents in north-eastern Italian Alps (2019–2021) and in south-eastern Norway (2013–2015), and applied multistate open robust design models to estimate the variability of demographic parameters under the experimental settings. Rodent assemblage was different at the two latitudes, with yellow-necked mouse, wood mouse (*Apodemus* spp.) and bank vole (*Myodes glareolus*) living in sympatry in Italy, whereas only bank vole occurred in Norway. In Norway, food scarcity and harsh climate seemed to limit rodent survival and abundance. In Italy, supplemental food promoted mice abundance, which in turn seemed to depress voles survival and abundance, most likely due to inter-specific behavioural and exploitative competition. The competitive mechanisms which we induced by providing ad libitum food resources may simulate population responses under climate change scenarios, with generalist species (e.g. Muridae) becoming prevalent part of the assemblage and overriding specialist species (e.g. Arvicolinae), also at the current extremes of their distribution range.

Assessing cost-effectiveness advantages of state-dependent agri-environment schemes

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Agri-environment schemes (AES) that perform state-dependent conservation measures are commonly associated with higher ecological impact, but also with higher monitoring costs than AES that perform state-independent conservation measures. As a result, it is unclear whether state-dependent or state independent AES are more cost-effective. In this paper, we investigate whether adjusting payments to farmers for differences in the impact of state dependent and independent conservation measures on harvest yields leads to cost-effectiveness advantages of state-dependent AES. To analyse this aspect we apply ecological-economic modelling to the case of endangered meadow birds' conservation in the Aller valley in Germany. Our results suggest that state dependent AES outperform state independent AES by far. However, cost-effectiveness gains are largely driven by higher ecological impacts and to a lesser extent by lower compensation payments to farmers.

Determinants of domestic cats (*Felis catus*) presence in natural landscapes of Spain: Implications for the role of domestic cats in ecological interactions

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Domestic cats are considered one of the main threats to biodiversity conservation worldwide. Most of the evidence was based on studies where the impact of predation was not based on prey demographic models or oceanic islands scenarios. We aimed to model the drivers of domestic cat presence in natural landscapes of Spain based on 12 camera-trapping over 60-day period surveys in 50 plots (2000 ha), covering all habitat and conditions. We estimated a number of variables around each camera (500 m buffer). As predictor variables, we used land-use variables, estimated the number and distance to the houses and the presence of red fox (*Vulpes vulpes*) and wildcat (*Felis silvestris*). We analyzed the 17 plots with the presence of domestic cats, using these as the response variable with the plot as a random factor applying GLMM with binomial errors. The final model revealed domestic cat was negatively related to wildcat presence and distance to houses and positively related to pasture cover. From this study, we can argue the potential impact of domestic cats on wild fauna is probably negligible, and because wildcats appeared to negatively affect domestic cats the potential scenario for hybridization between both species can be suggested as of minor relevance.

Designing reintroduction strategies in Cinereous vultures

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By the ends of the XX century, the European scavengers populations had dramatically decreased and the cinereous vulture could only be found in the Iberian peninsula.

Release projects were developed in France in the 90's and it became clear that communication between this new populations and the remaining Spanish ones was crucial.

After a feasibility study, GREFA developed a reintroduction program in the Pyrenees during the early 2000's in order to build this connection and, later on, a second reintroduction in Burgos to increase the movement within the new colonies.

During the last decade, the number of individuals that travel within this brand new meta-population have increased, giving relevant information that will allow GREFA and other organizations to design new strategies and release programs.

Assisting Rangers to Halt Poaching Activities with Green Stochastic Games

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Given the scarcity of available information on poachers' activities in vast conservation areas, game theoretical methods can assist rangers in devising strategies to curb illegal poaching, while considering the poachers' decision-making behaviours. We introduce a formal stochastic game model, along with a solution approach interleaving dynamic programming and Nash equilibrium computation. Rangers and poachers are assumed to be non-cooperative players who make decisions simultaneously. Different from previous works (some use for example Stackelberg game), our stochastic game model considers the probabilistic dynamics of the game situation, modelled as a Markov decision process. Furthermore, we analyse results obtained from benchmarking against an iterative strategic game approach, in which normal-form games are solved at each decision-making round, without considering the probabilistic dynamics. We also analyse the performance of our solution method on games of varying size, rewards definition, game topology (considering sites with different geographical and ecological features) and players' mixed capabilities (e.g. aerial support for rangers). Finally, we outline possible extensions of our work, aimed at lifting some assumptions by considering i) imperfect state observation, ii) more complex interactions between poachers, rangers and animals' dynamics, as well as iii) players' different subjective preferences.

Effective restoration of species-rich grasslands: the importance of timing in sowing target species seeds

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The abandonment of agricultural lands is a global problem but it also provides an opportunity for grassland restoration and halting ecosystem degradation. Low- or high-diversity seed-mixtures application is a frequently used method to restore species-rich grasslands. When applying both, the timing of seed-mixtures sowing is essential. We aimed to identify the most efficient timing of seed-mixture sowing to maximize restoration success. We applied grass-seeds, divers forb seed-mixtures (DM) and the combination of the two in a recently abandoned cropland. Grass-seeds were sown in the first year of the experiment. DM was sown simultaneously or 1, 2 or 3 years after the sowing of grass-seeds, in plots previously sown with grass-seeds or in empty plots (fallow). The results highlight the efficiency of both grass-seeds and DM in covering bare soil and suppressing weeds. Sown forbs performed better when sown in fallows, especially in younger ones. DM sowing with grass-seeds was effective only in simultaneous sowing or with one-year delay. Later introduction of forbs was less successful, and can be costly as needs the severe disturbance of the existing vegetation. Based on our results, we recommend restoration shortly after cropland abandonment and the introduction of target species simultaneously to the area.

Putting drylands on the map: definitions, designations, and conservation status of global arid landscapes

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Drylands encompass a large part of Earth's land surface, supporting vital

human and natural environments. These unique and fragile desert ecosystems are especially vulnerable to increasing land conversion to agriculture and other land uses. Yet drylands are often neglected as regions for conservation concern, predominantly from a global perspective. A major barrier facing conservation planning in such regions is the application of several classifications and designations (e.g., dryland, desert, arid landscape, etc.) – comprising similar, broad and non-overlapping regions. We examined several dryland designations, categorizations, definitions, and mapping initiatives to evaluate the degree of global congruence among desert regions. We find that relative to other biomes, deserts are among the least protected by designated conservation areas aimed at protecting biodiversity (i.e., IUCN categories I–IV). We also identify 'core' regions of drylands identified as such across all designations, in addition to many regions falling under one or few dryland designations. These attributes were further highlighted in major dryland regions separately, revealing regions of very low protection and high human land-use pressures (e.g., Asia). Clarifying and identifying dryland classifications and their spatial distributions is integral to determining potential threats and requisite conservation interventions in desert regions globally.

Microclimate in hollow trees and how it affects an inhabiting beetle species, *Osmoderma eremita*

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While climate warming has sparked the studies of microclimatic conditions in many habitats, knowledge on the role of microclimate for insects inhabiting hollow trees, the severely decreasing habitat type, is still lacking. We explored relationships between tree characteristics and microclimate in tree hollows, and how these affect the occurrence and body size of an endangered beetle *Osmoderma eremita*.

We placed data-loggers in wood mould and surveyed *O. eremita* with mark-recapture in south-eastern Sweden. Tree diameter and entrance height were especially important for the microclimate in tree hollows, while wood mould volume, direction and angle of the entrance were also included in several models. Trees with larger diameter were warmer in autumn and winter but colder in summer with lower temperature fluctuations in summer. Hollows with higher entrances were warmer in spring and summer, but colder in autumn and winter.

O. eremita occurred more frequently in hollows situated higher from the ground with warmer and stable microclimate. Beetles were larger in trees with south-facing entrances with colder and had more stable microclimate. In summary, the occurrence and body size of *O. eremita* were strongly correlated with microclimatic conditions, which may be especially important near the northern range margin of the species.

Modelling population viability analysis of isolated green lizard populations as an implication for translocation

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The aim of our study is to use the information about long-term changes in abundance and genetic diversity of two populations of *Lacerta viridis* to prevent the possibility leading towards extinction. Those two populations are located in the Czech Central Highlands, which is one of the northernmost place from European distribution of this species. We found out that the population size and the genetic diversity of one population are significantly lower than the other one. The low abundance and genetic diversity of the weak population are the results of the effect of inbreeding and lack of migration. One possibility to force the threatened population is a translocation of some individuals from the stable population. Our idea is to use the population models to get knowledge about some key variables from several scenarios. The key questions are: what is the minimum size of the viable population, how many individuals can we translocate to support abundance and genetic diversity of the threatened population, but not to hurt the stable population, and what would be the predicted genetic variability of both populations. Our goal is also to gain better knowledge about future management which would keep those two populations viable.

Human-vectored seed dispersal: A potential threat to the flora of protected areas

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In our daily lives, we often notice a large number of seeds and fruits attached on our clothing and footwear. There are several studies that highlight environmental problems caused by the human-vectored seed dispersal (HVD) and subsequent establishment of non-native seeds in protected areas. In a multi-site field experiment we collected propagules from socks and shoes from volunteer participants. In the analyses we used variables related to the movement of people, their clothing and the visited habitats. A total of 250 samples were collected from 87 people in Hungary, Romania and the Czech Republic. We have identified 219 species of 35933 fruits/seeds. We also conducted a questionnaire survey, which showed that most people already clean their footwear from diaspores in the field, while others prefer to leave these propagules in their footwear. According to our results, HVD can support the dispersal of many plant species, especially disturbance-tolerant and weeds in Central-Europe. Therefore, it is very important to minimize the chances of these species spreading in the nature reserves. Furthermore, it is essential to keep visitors properly informed about this phenomenon.

Where agri-environment schemes do not exist

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The loss of agrobiodiversity due to agricultural intensification led to designation and implementation of environmentally friendly measures such as EU agri-environment schemes (AES). While in Serbia there are designated un-managed areas and Zones of conservation importance there are no AES to combat continual diminishment of species and their habitats in agricultural settings. Here, we took a set of landscape elements recognized as surrogates to EU agri-environment measures and examined their importance for 4 selected species present in highly productive Bačka region. We estimated the effect of these semi-natural elements on species habitat suitability, the spatial scale at which the surrogates are most effective and distribution of habitat suitability to propose adequate conservation measures within designated conservation areas and Zones. We used high resolution land use/cover data (10x10m), multi-scale ensemble SDM and species data. Our results show that the effects vary across species. The most beneficial measures in combination with grassland presence are grassland maintenance, linear elements, and crop diversity at local and landscape scale. Since the effects vary across species and scales, we need to diversify agricultural landscape through adequate spatial targeting and farmers-collaboration to ensure varied mix of habitat types and agricultural practices in existing conservation areas and Zones.

Effects of indiscriminate poaching on the population persistence of a non-target species of conservation concern

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The conservation of biodiversity represents a profound challenge for global society in a dynamic 21st century. The threats to biodiversity are many including habitat loss, climate change, disease, invasive speciation, conflict, and hunting. Illegal animal harvest, a contributor of biodiversity loss, occurs along a relative selectivity spectrum from indiscriminate to highly selective. Extensive research has evaluated the impacts of selective harvest on animal populations. In contrast, the ways in which indiscriminate harvest pressure shapes populations of non-target species is unclear. We used simulation modelling to predict the persistence of an African lion population (*Panthera leo*) subject to indiscriminate harvest pressure from non-target sub-

sistence poaching in Murchison Falls National Park, Uganda. Simulations predicted lion population extirpation following a 50% rise of lethal poaching pressure above the observed. When lethal poaching pressure doubled, the lion population was extirpated in ~70% of our simulations. In simulations in which subsistence poaching as a lethal pressure was eliminated, the lion population nearly doubled in just 19 years. We discuss how indiscriminate poaching can affect non-target species and describe interventions to effectively promote population recovery of species of conservation concern.

Habitat Relationship Model for Terrestrial Vertebrates in an Urbanizing Region

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Rapid urban expansion is contributing to the present biodiversity crisis. Urban planners and conservationists need tools to evaluate habitat impacts due to urbanization. To address this need a user friendly rapid habitat assessment tool was developed. It uses an integrated series of databases that link forest composition, vegetative development stage, forest and non-forest structure, and non-forest habitat features with maps of known vertebrate distribution. The habitat assessment tool was tested using presence/absence data for 29 commonly occurring herpetofauna collected by the State of Maryland USA over a two year period on seven sites within the Piedmont Plateau physiographic province. The assessment tool correctly predicted the presence of 97% of the herpetofauna. The overall omission error rate was 3%, suggest that the model is achieving improvements in accuracy over earlier wildlife habitat relationship models, a possible outcome of its narrow geographic focus and its focus on using local and regional habitat descriptions when available. The average commission error rate was 43%. A significant goodness of fit was found between the observed and predicted herpetofauna at the 7 inventory sites ($\chi^2_{20.05}$, 6df = 0.9, $P > .975$).

The first comprehensive data on the distribution of reptiles within the Southern Bug eco-corridor, Ukraine

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Reliable maps that depict the current distribution of species are an important component in conservation-related research, especially for reptiles. Ukraine is one of the least studied countries in Europe for reptiles. In this study, we report on the first comprehensive study on the distribution of reptiles in the Southern Bug eco-corridor located within the steppe zone, Mykolaiv Oblast (province), Ukraine. Our study provides distribution data for 12 species of reptiles in this area. We compiled 935 records from published literature (324), from public databases (68), and from 12 field surveys we made 2016–2020 (543). We present new distributional data for *Podarcis tauricus*. For all the other species, our records add new localities that fall within areas where these reptiles were previously reported. The studied oblast is inhabited by reptiles that are locally abundant (*Lacerta viridis*, *Dolichophis caspius*), or rare (*Coronella austriaca*, *Vipera renardi*). Additionally, the local population of *Zamenis longissimus* is the only one known in the steppe zone of Ukraine. Species richness and Shannon's H' index show that herpetofauna diversity was higher in the areas along the Southern Bug River. The results of this study show that southern Ukraine is an important territory for conservation activities in Europe.

What moves citizens to engage in wildlife conservation activities? The case of European bison, moose and wolf in Germany

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While the return of large mammals to their former habitats in central Europe is embraced as the result of successful conservation measures, it also is a controversial topic and bears potential for human-wildlife conflicts. As citizen science (CS) has been suggested to be effective for involving citizens in wildlife research and mitigate these conflicts, we conducted a survey in two wildlife parks located in different states of Germany. We assessed the visitors' knowledge level of three returning species: European bison (*Bison bonasus*), moose (*Alces alces*) and grey wolf (*Canis lupus*) and respondents' readiness to participate in CS for monitoring and managing these species. We developed generalized linear models to 1) understand how sociodemographic variables affected citizens' knowledge of each species, and to 2) investigate if sociodemographic variables and knowledge influenced the likelihood of visitors to participate in CS activities. Almost all citizens were aware of the returning wolf, while knowledge and awareness about bison and moose were significantly lower. Younger interviewees and those with higher knowledge levels were more willing to participate in CS activities. Our analyses highlight how knowledge about wildlife and human demographics are interrelated – insights that are helpful for effectively recruiting citizen scientists for wildlife conservation.

Mapping paleochannel grasslands and their conservation opportunities in an agricultural commodity frontier of South America

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The South American Dry Chaco harbors azonal grasslands in ancient river beds (paleochannels). These grasslands host a wide range of species and provide ecosystem and cultural services. Besides, paleochannels offer a significant economic profit with a minimum investment for their use due to high fertility, flat relief, and natural vegetation easy-to-mechanically-removal. This promotes the replacement of grasslands by cultivated landscapes. However, a lack of basic characterization of the paleochannel grasslands challenges their conservation. For the first time, we mapped and described paleochannel grasslands based on their land cover, spatial configuration, primary productivity, fragmentation, and protection. We observed that grasslands in low-transformation matrices were mainly replaced by shrubs, which increased their primary productivity. The proportion of cropland inside paleochannels increased with increasing matrix transformation, promoting a high fragmentation by croplands and roads. Moreover, the majority of paleochannel grasslands were not included in any protection scheme. Our results suggest that natural (shrub encroachment enhanced by overgrazing and fire management prohibition) and anthropogenic processes (agriculture and roads) are turning grasslands into woody-dominated or agricultural systems. Finally, we proposed a set of highly productive, grassland-dominated paleochannels located in the NW of the Dry Chaco that should be included in future conservation and management strategies.

Animal-Visitor Interactions (AVIs) in South Africa: a participatory approach to facilitate ethical reasoning

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South African animal facilities offer visitors several different types of Animal-Visitor Interactions (AVIs), in which visitors come into close contact with wild animals. Understanding the implications of AVIs for animals, people, and conservation needs an accurate ethical analysis. This study explores the ethical dimensions of AVIs in South Africa by means of a participatory approach based on the Ethical Matrix (EM) tool. A participatory approach was used to collect information about value dimensions and potential conflicts from stakeholders. A one-day workshop with members from five stakeholder groups (owners

and managers, veterinarians, academic researchers, governmental representatives, and keepers) has been held. A dedicated survey has been filled in by 14 employees of animal facilities and by 173 visitors who participated in AVIs. The outcomes were used to tailor and refine the EM, providing a map of the ethical standings concerning AVIs. Results show that ethical acceptability is linked to different animal welfare and management issues, and highlight the importance of cooperation between stakeholders, suggesting that attention to animal welfare should be carefully considered. The structured approach based on the Ethical Matrix proved to support an informed decision-making, facilitating a multidisciplinary approach to assess biodiversity conservation, education, and AVIs management.

Species interactions disrupted by roads

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The road network is an ever-growing human infrastructure with serious impacts on nature, so it is important to understand how roads influence the natural flow of ecosystems and the relationships between its components. We conducted a literature review on how species interactions can be altered by roads using on the Web of Science. We used the terms “road” and each one of the common interaction types. The initial search returned 1023 articles, that we filtered by title an abstract, finally retaining 92. The results of our search showed how some interactions have been given more attention than others and only a few of the articles revised were conducted in developing countries, where knowledge about this topic is crucial. Moreover, some specific road impacts have more representation than others, with road de-icing salts, landscape changes, road margins alterations and road noise, as the most studied impacts. Overall, we found a lack of research covering multiple taxa and their relationships, a lack of studies at a population scale and a lack of articles focused on the possible road-mediated cascade effects derived from these alterations of interspecific relationships. These gaps of knowledge may impede us to accurately mitigate the effects produced by roads.

To a charismatic rescue: Designing a blueprint to save fishing cats, aiding in wetland conservation

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Flagship species conservation approach has the potential to enrich wetland conservation. Conserving the charismatic Fishing Cat (*Prionailurus viverrinus*) in India, supporting ~40% of its known range, can help protect wetlands. Here, using multiple information sources we outline a framework at district level to safeguard fishing cats in India. Specifically, we a) estimated Conservation priority scores (using presence records, habitat suitability, and habitat connectivity) to identify ecologically important habitats, b) estimated Conservation likelihood scores assessing the success potential of any conservation intervention, c) collated Conservation initiative information identifying ongoing efforts for species and/or habitat conservation. We consecutively assessed the spatial congruence between (a), (b) and (c) to delineate species' conservation areas and corresponding action goals (blueprint). Although Fishing Cat records were found in 12 Indian states, only a small proportion of the state area was identified harbouring optimal habitat for the species. Most districts ranking high in Conservation priority scored low in Conservation likelihood. Districts with species presence (n=60) were delineated into four tiers of action landscapes while some districts lacking confirmed presence records (n=156) were classified as survey landscapes. We use our results to recommend conservation actions for fishing cats in India and explore its potential in protecting neglected wetland ecosystems.

Grassland type and seasonal effects have a bigger influence on plant diversity than prairie dog disturbances in semi-arid grasslands

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Prairie dogs (*Cynomys* sp.) are considered keystone species and ecosystem engineers due to their grazing and burrowing activities (summarized here as disturbances). As climate changes and its variability increases, the mechanisms underlying organisms' interactions with their habitat will likely shift. Understanding the mediating role of prairie dog disturbance will increase knowledge on these mechanisms and the vulnerability of grasslands. Here, we studied how plant taxonomic diversity and functional structure respond to prairie dog disturbance across grassland types and seasons in a conservation priority, semiarid grassland of Northeast Mexico. We found grassland type and season explained most of the effects on plant taxonomic diversity and functional structure. Contrary to other studies, we further found weak evidence that prairie dog disturbance has a negative effect on vegetation structure, except for effects on C4 and graminoid cover, which however mainly depended on season. Our results provide evidence that environmental effects have a stronger role than grazing and animal disturbances on vegetation. We argue that a focus on disturbance and grazing effects is misleading, and instead attention is needed on the relationships between vegetation and environmental conditions which will be critical to understand semi-arid grassland dynamics in the region.

Population genetics of the Black Grouse in the Czech Republic after twenty years of strong decline

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In the Czech Republic, black grouse populations have declined since the mid-20th century and particularly dramatically in the last two decades. Population genetic study based on non-invasive material collected in the Czech border mountains in 2004–07, revealed relatively low dispersal between sampled localities. However, existence of three main clusters, i.e. Šumava Mts, Krušné hory Mts and both Jizerské hory and Krkonoše Mts, indicated that gene flow within these mountain ranges was still occurring (Svobodová et al. 2011). Some 15 years later, the whole distribution area of the species in the country was sampled again. In total, more than 300 individuals were identified based on ca 1000 samples collected in Šumava, Boletice, Krušné, Doupovské and Jizerské hory and Krkonoše in 2016–21. These data are now being analysed to evaluate changes in genetic variability and genetic structure (gene flow) of the Czech black grouse populations. The data will further allow to estimate abundance of the species in a model area and to determine movements of individual birds. Obtained results will serve as a basis for effective decision-making in the conservation management of this endangered species.

Isolation by time in a terrestrial vertebrate: a potential mechanism for sympatric speciation

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Isolation by time can lead to sympatric speciation based only on different reproduction times (allochrony). The few known examples of such separation operate due to a life cycle longer than a year in a semelparous organism (reproduces once in its lifetime). There were no examples of this phenomenon among terrestrial vertebrates. We found that *Chamaeleo chamaeleon musae*, a desert chameleon, has several characteristics that may lead to this separation. These chameleons reproduce a year after hatching and only 0.2% of the population survives to the second reproductive season. This forms two subpopulations: the first reproduces during even years and their eggs are incubated during odd years, while the second subpopulation uses opposite years. As a result, the two subpopulations rarely have the opportunity to mix. We found that survival varies depending on the subpopulation and on precipitation during incubation. This unique lifestyle can be a consequence of climatic changes and may become more common in the coming decades. This chameleon is the first terrestrial vertebrate that exhibits a potential allochronic lifestyle that can lead, or has already led, to genetic divergence between sympatric subpopulations. This is a rare opportunity to study this unique form of separation in progress.

Assessing cost-effectiveness of agri-environment schemes under climate change: the case of meadow bird conservation in Northern Germany

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Intensive agricultural land use is one of the most important threats to species. One policy option to conserve species in agricultural landscapes are incentive-based instruments such as the implementation of conservation measures defined in payments for ecosystem service schemes or agri-environment schemes (AES). A key criterion to assess the suitability of an AES is cost-effectiveness. Additional complexity in the assessment arises when considering the threat that climate change poses for species conservation. Under climate change, initially cost-effective conservation measures need to be adapted to remain cost-effective. To develop recommendations for the necessary adaptations, the impact of climate change on both the species and on costs of conservation measures has to be considered. We developed a climate-ecological-economic model and examine the cost-effective spatio-temporal allocation of AES measures in the near (2020–39) and remote future (2060–79). We specifically model the impact of climate change on both the species and costs and consider two climate scenarios, RCP4.5 and RCP8.5. We apply the model to the case study of conserving a set of meadow-breeding bird species in Schleswig-Holstein, a Federal State in Northern Germany. Our results show how AES need to be adapted to remain cost-effective under climate change.

Investigating the potential for hybridisation between non-native *Eriocheir* mitten crab species in the River Dee.

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The Chinese mitten crab, *Eriocheir sinensis*, is listed as one of the World's 100 most invasive species and has been recorded in the River Dee, a special area of conservation, since 2006. Sequencing of the mitochondrial Cytochrome Oxidase 1 gene indicates that mitochondria originating from two different *Eriocheir* species are present in the Dee

mitten crabs. We use morphometrics and single nucleotide polymorphism (SNP) genotyping to investigate whether the Dee mitten crabs comprise two separate, cryptic species or a single hybrid swarm. Mitten crabs were collected from Chester Weir in the River Dee at two time points in 2014–15 and 2020 and additional reference samples were collected from each of the putative parental species. Morphometrics were carried out following Clarke et al. (2000) and DNA samples were submitted for SNP genotyping. Understanding the taxonomy and potential to hybridise of the genus *Eriocheir* is important, given the biosecurity threat posed by mitten crabs and the potential for hybrids to exhibit greater invasiveness than their parent species.

A global analysis of habitat change research in reptiles and amphibians: What have we done so far?

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Habitat change and fragmentation is the primary cause of biodiversity loss worldwide. Recent decades have seen a surge of funding, published papers and citations in the field as current threats to biodiversity continue to rise. However, how research directions and agenda are evolving in this field is still poorly understood. In this study, we examined the current state of research on the most threatened groups of vertebrates, reptiles and amphibians. We did so by conducting a global scale review of geographical and taxonomical trends regarding habitat change and the associated sampling methods and response variables. We reveal a number of biases, in particular that existing research efforts are characterised by distinct continents (e.g. North America) and study groups and a surplus of studies measuring species richness and abundance with seemingly contradictory results. However, we found a recent shift in research agenda towards studies utilising technological advancements including genetic and spatial data analyses. Our results suggest important associations between sampling methods and the response variables measured which are commonly used in explaining effects of different types of habitat change. Increased research investment with appropriate sampling techniques is crucial in biodiversity hotspots such as the tropics where unprecedented threats to herpetofauna exist.

Protecting terrestrial communities from climate change – invasion synergies on South Georgia Island.

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Context

The effects of climate change are already marked on South Georgia Island, with rapid glacial retreat. In parallel, the island continues to harbour non-native invasive plants and invertebrates, posing a threat to native ecosystems, with some species now so widespread that eradication is impossible.

Objectives

Our project will assess the vulnerability of South Georgia's unique terrestrial ecosystems to invasive plants and invertebrates that may benefit from climate change.

To do so, we will:

- 1) Record colonisation of recently deglaciated areas by non-native species.
- 2) Identify 'winning' and 'losing' native and non-native plants under simulated warming.
- 3) Map invasive carabid beetle and native invertebrate distribution and abundance.
- 4) Identify high-risk potential future invaders from the Falkland Islands.

Impact

This research will generate information that will directly help conservation management on South Georgia in a warming climate.

Serious mathematical biases in the calculation of the Living Planet Index

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The Living Planet Index (LPI) measures the overall population trend of vertebrate species during last decades and has been repeatedly used for evaluation of the current state of the biosphere. The Living Planet Report, published by WWF, states, based on the LPI, that vertebrate populations decreased by more than two-thirds since 1970. This is in striking contrast with the studies based on the same population data (Living Planet Database, LPD) which show that in average, increasing and decreasing vertebrate populations (winners and losers) are more or less balanced. We show that the calculation of the LPI is seriously biased by several mathematical and statistical issues which produce asymmetry in weighting decreasing and increasing populations. When these errors are corrected, the recalculated LPI does not show overall significant decline nor increase of vertebrate populations. This does not necessarily mean that the human-made changes in the Anthropocene lead to a perfect balance of winners and losers; instead it may indicate that available data (collected in the LPD) are not sufficient for proper evaluation of the current state of the biosphere.

Managing climate change impacts on land use and ecosystem services

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Adaptation to climate change requires rethinking of land use management paradigms and strategies and proposing changes to existing practices to make them functional under future environmental conditions. The project combines (i) quantitative indicator-based assessments and cartographic representations of key ecosystem services in Austria and (ii) an agent-based model (ABM) for fine-scale climate-induced land use change. In two case study areas in central and eastern Austria, the agent-based model is implemented in three scenarios for the years 2017 to 2050, taking into account socio-economic and climate change. It provides predictions for land use at very high land parcel resolution. The changes caused by Climate change and land use change triggered changes in nine ecosystem services. (high nature value agricultural land, habitats and species, habitat type fragmentation, soil conservation, insect pollination, soil C sequestration, soil fertility, agricultural production, and drinking water) are subsequently derived, and land use policy tools and targeted recommendations to increase system resilience and address ecosystem service loss are identified.

Re-zoning Our Conservation Area: Incorporating Socioeconomic Factors to Spatial Multi-Criteria Analysis in Mangrove Conservation Planning

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Mangrove ecosystem is contributed to many greater benefits for both human and environment by providing shelter, foods and protect coastal-line from tsunami and abrasion. It is important to have a suitable management plan for mangrove to support its functions and benefits. Here we used not only ecological and spatial data, but also incorporate with socioeconomic data to help determine a good mangrove conservation site. Using case study, in Baros mangrove, Indonesia, we identify set of parameters and criteria to help us building a good judgement for feasible mangrove conservation site. The degree of importance was determined using Analysis Hierarchy Process (AHP), for weighting the criteria and scenario of management options that we proposed. Our results showed that the centre of mangrove area in Baros is suitable for utilization, the buffer area is suitable for recreational and educational activities and the outer area is suitable for protection. This finding showed an opposite concept of conservation zone made by UNESCO, where the centre/core zone of ecosystem is suitable for protection and the outer is suitable for commercialisation. We argue that we need to be more careful in determining conservation zone especially in mangrove ecosystem which has a unique habitat than others.

The potential of using biosynthetic metabolites of entomopathogenic bacteria in the mitigation of amphibian chytridiomycosis

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Chytridiomycosis, caused by the chytrid fungus *Batrachochytrium dendrobatidis* (Bd) has caused extreme losses in amphibian biodiversity. Finding bacteria for probiotic therapy with the purpose of disease mitigation which produce metabolites with antifungal properties may turn out to be invaluable in the fight against chytridiomycosis. The entomopathogenic bacterium, *Xenorhabdus szentirmaii* produces secondary metabolites that are effective against a wide range of fungal plant pathogens. To assess whether it may also be effective against Bd, we extracted cell-free culture media (CFCM) from liquid cultures of *X. szentirmaii* and tested their disinfecting efficacy at dilutions of 10 and 2 %, while also measuring possible malign effects on juvenile common toads (*Bufo bufo*) experimentally infected with Bd or sham infection. We detected no negative treatment consequences on the survival and body mass of uninfected toads. However, among infected individuals, survival was higher and infection intensity was lower due to the 10 % CFCM treatment, compared to toads treated with no, or 2 % CFCM solution. Efficacy is likely due to the fabclavines but this needs to be verified. Nonetheless, these results support the potential of using *X. szentirmaii* metabolites in the development of a new, non-invasive, chemical-free, and cheap method for Bd disinfection.

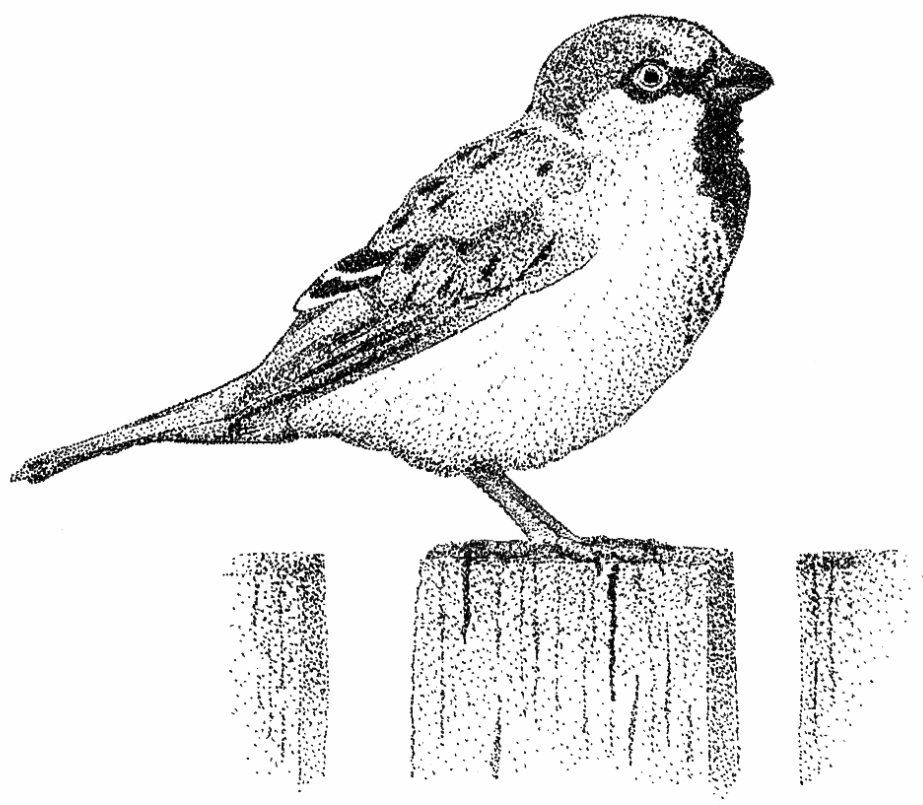
Continuous country-wide forest monitoring through remote sensing-based yearly assessments of forest status

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In 2018, 2019 and 2020, periods of droughts and pests such as the bark beetle have particularly hit conifer monocultures hard in Germany and revealed how vulnerable many forests are. Additionally, forest fires and the expansion of open-cast mining (coal, gravel, sand, etc.) have contributed to forest damage and forest loss. Since the droughts of recent years, the abundance of bark beetles and other calamity factors highly differed between regions, the extent of forest damage varies greatly. A yearly in-field forest status assessment at fixed sampling plots is realized to identify how severe this forest damage is in Germany. Since this assessment cannot be done at full coverage, a satellite-based monitoring system is needed to map the forest damage and forest loss at high resolution and country-scale. In order to address this need, the “Forest Monitor Germany”, which uses a long time series of Sentinel-2 data with 10 m spatial resolution to assess changes in the forest status, was developed (<https://map3d.remote-sensing-solutions.de/waldmonitor-deutschland/#>). Established vegetation indices were calculated based on time series and trend analyses were applied in order to identify positive or negative changes in forest stands in regard to forest biomass and foliage water balance.

Abstracts of posters and E-posters



Graphics by: Sarah Maršíková
Passer domesticus

Investigating genetic connectivity of rare scattered tree species in Austria to inform conservation management plans

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With the progression of climate change, ecosystems and biodiversity threats continue to grow. While a decline in the distribution range of some of the main forest tree species in Central Europe is predicted, some species will indeed be able to expand their range. The WILDOBST project focuses on three such species: *Pyrus pyrauster*, *Sorbus torminalis*, and *S. domestica*. Their projected range expansion, paired with their ability to provide food and habitat for a wide range of organisms heightens their importance for maintaining and enhancing biodiversity. However, in order to ensure these species maintain their full potential, it is important to understand and enhance the available genetic diversity, as all three species are currently rare and have a scattered distribution. WILDOBST is investigating the genetic connectivity of populations across Austria to identify populations of particular conservation importance and suitability as sources of reproductive material, as well as to inform management plans to be implemented across Europe. To further inform this project a review is being conducted on the state of genetic research of European Rosaceae trees to understand conservation requirements, research biases, and knowledge gaps.

Detection of Cytochrome P4501A in cyprinid species across varied trophic gradients of Himalayan Lakes– A Potential Biomarker for Polluted lakes

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Kashmir valley lakes are facing a challenging effect of cultural eutrophication from the last few decades and it remains as the main water quality management problem. The physicochemical parameters of four flood plain lakes of Kashmir were studied for two seasons viz summer and winter in different lakes. The aim was to detect and quantify cytochrome P4501A in cyprinid species collected from Dal, Wular, Manasbal & Nilnag lakes and control group. The lakes are at varied trophic gradients. Cytochrome P4501A was detected in all the samples examined throughout the study. Using one way analysis of variance, $P < 0.01$ was obtained which indicated that there was a significant difference ($P < 0.05$) in Cytochrome P4501A levels among the 4 sampling sites. Further, it was observed that Cytochrome P4501A showed the positive significant correlation with both total phosphorus ($r = 0.90$; $r = 0.89$; $r = 0.94$; $r = 0.88$ respectively, $P < 0.05$) as well as nitrate nitrogen ($r = 0.87$; $r = 0.88$; $r = 0.95$; $r = 0.80$, respectively $P < 0.05$). It was evident from the present study that with the increase in phosphate and nitrate content, Cytochrome P4501A levels also increased considerably. The lakes are in state of stress due to poor management practices, pesticides, poor performance of sewage treatment plants, species invasion and societal disconnect harming the wellness of lakes.

Is the online wildlife trade gradually becoming a threat to pangolin Conservation in Nigeria?

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Online platforms are gradually becoming an avenue for illegal wildlife trade in Nigeria. The internet for trade has opened a wide gate of opportunities for wildlife poachers and vendors to reach a wide range of customers and increase their sales around the world within a record time. Pangolins are hunted for their scales, and body parts traditionally possess mystic powers to heal all manner of sickness and ailments. The fetus of Pangolins is believed to aid safe parturition and cure fibroid in women. At the same time, the skulls and bones are used for good fortune charms and talismans, which the youths be-

lieve can offer security and attract wealth, promote business, or make people rich quickly. Due to the high local and international market demand, there is huge pressure on wild pangolins, almost hunted to extinction. Global access to the internet makes online wildlife trade possible in Nigeria. Twenty (20 %) per cent of wildlife traders interviewed during this study agreed to have sold bush meat through online social media platforms. This attests that the online wildlife trade is gradually rising in Nigeria and thus calls for urgent attention.

Emotional diversity and attitudes towards wolves in France

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Emotions are expected to play an important role in human-wolf co-existence, yet they remain relatively seldom investigated. While most studies on emotions have focused on emotional dispositions towards wildlife, context-specific emotional reactions and their relation to attitudes have been little studied. In this study, we elicited emotional reactions to six types of encounters with wolves (*Canis lupus*) using amateur Youtube videos and looked at relationships between emotions and attitudes. We targeted rural populations of 24 randomly selected cities in France ($n = 796$), comparing regions where wolves have permanently recolonized and where they are absent, with two objectives: to investigate the diversity and intensity of emotional reactions to wolf encounters, and to test the relationship between emotional reactions and attitudes. We used a multidimensional approach inspired from functional ecology to investigate emotional diversity, and found significant variations in emotions across the six encounter types. We found that emotions explained a significant amount of variation in attitudes towards wolves. Our results together demonstrate the great variety of emotions (and not only fear) associated with large carnivores. They also highlight the importance of emotional diversity, in combination with individual and context-specific factors, in shaping attitudes towards large carnivores.

Population-level dietary selection of a European grassland specialist near its upper distribution limit in Serbia

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Diet, one of the most essential life activities, is connected to almost all other aspects of an animal's life. Especially for hibernators living at high altitudes, such as European ground squirrel (*Spermophilus citellus*, EGS) populations in southern Serbia, choices of food can be of detrimental importance, considering that hibernation survival and reproductive success are directly influenced by the fat deposits acquired during the shortened active season. We studied the dietary resources selection of two EGS populations on the high montane meadows of south-eastern Serbia. Diet was analyzed using the microhistological analysis of feces. Dietary resource selection was quantified using the Ivlev's index of electivity. The majority of the plant food eaten belonged to the four categories: daisies, legumes, grasses, and *Cerastium banaticum*. Despite constituting, on average, 13% of the diet, Ivlev's index values for grasses were repeatedly negative, marking them a secondary food choice. Compared to forbs, the nutritive values of grasses are lower, so this result doesn't surprise, but it has important implications for the species populations in high-altitude habitats. Furthermore, this result should help steer the management of EGS habitats to quantify and improve the fine-scale vegetation diversity, thus increasing the availability of the more preferred food types.

Deadwood, herb layer and bird response on conservation-oriented active management of Hungarian Natura2000 oak forests

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In the framework of a running LIFE project (LIFE4OakForests), we started the conservation-oriented management in three protected forest areas in Hungary to enhance structural and compositional complexity in 2018. Active management has been started on the 19 pilot sites and affected approx. 1000 ha Natura2000 oak and hornbeam dominated oak forests altogether. Among others, these actions included the girdling of standing living trees, bark stripping of tree individuals, felling to create downed woods and high stumps. The baseline survey of several species groups has been finished, and the post-intervention monitoring started. Preliminary data shows that the original volume of deadwood and the number of microhabitats were generally multiplied on each monitored site that had undergone some intervention. The cover of the herb layer species increased significantly two years after the treatments, but species diversity did not increase. We detected the rapid answer of woodpeckers by the fast utilization of the treated trees. We found a significant difference between deadwood types and tree species in foraging activity; girdled trees and *Quercus petraea* and *Q. robur* species attracted the highest activity.

Effects of natural and forestry caused disturbances on plant communities in European beech forests

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Many empirical studies have found positive effects of forestry on plant alpha diversity in temperate deciduous forests, reflecting a positive response to soil and canopy disturbances caused by forestry operations. The level to which this positive response to artificial disturbances mimics processes in natural forest ecosystems is less clear, and hence the systemic effects of forest management on the ground floral communities remain obscure.

We studied communities of ground-dwelling bryophytes and vascular plants in four classes of forest management intensity, while re-cording the incidence of a diverse array of microhabitats related to hydrology, canopy and soil disturbance.

We found weak positive effects of forest management on alpha diversity of both plant groups. In contrast, the uniqueness of assemblages – measured as range rarity richness – decreased with forest management intensity. Canopy gaps created by thinning had a similar effect on alpha diversity to natural tree-fall gaps, but supported a different set of species. Similarly, natural watercourses and wet depressions supported more species of bryophytes and more unique floras of both groups than did artificial ditches.

Long unmanaged forest reserves are essential to providing habitat to forest specialist species, even for light-dependent organisms such as bryophytes and vascular plants.

Assessing the joint potential of European forests for climate change mitigation and biodiversity conservation

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It is now widely accepted that climate change mitigation and biodiversity conservation are deeply connected and must be faced jointly. Forests are of primary relevance for both these major environmental challenges. Our study aims to assess the synergies and trade-offs related to these challenges in European forests.

We harmonized forest structural and biodiversity data from 2,282 sampling units across European countries. We calculated living trees and deadwood C stocks, and species richness for 6 taxonomic groups (Birds, Epiphytic Bryophytes and Lichens, Saproxylic Beetles and Fungi, Vascular plants). The species richness of each taxonomic group in each sampling unit was standardized by scaling its value against the asymptotic richness for that taxonomic group at the site scale through the package iNEXT. We used LMM to estimate the relationship between C stocks and scaled species richness of different taxonomic groups at a continental scale, accounting for management strategies effect.

The Carbon/diversity relationship is generally positive, supporting the hypothesis that forest management can be used to mitigate biodiversity loss and climate change. However, this relationship varies greatly across taxonomic groups and carbon pools. Results suggest the need for tailored choices to address forest multifunctionality in the face of the ongoing environmental crisis.

Landscape genomics of the oligolectic wild bee *Andrena vaga* along an urbanisation gradient

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Urbanization is a global change phenomenon that leads to greater habitat loss, fragmentation and degradation, increased pollution and more impervious surfaces compared to nearby non-urban habitats. The combination of these effects constitutes a challenge for the survival and persistence of many species, including essential ecosystem services providers like wild bee pollinators, whilst also imposing altered selective regimes. Urban ecology has provided significant insights on how urban environmental changes affect bee species community structure. However, we know little about how the ecological impacts of urbanization affect the evolution of wild bee populations living in cities. Here we use genome-wide single nucleotide polymorphism data to investigate the genome-wide effects of urbanization on neutral and adaptive genomic diversity in an oligolectic wild bee, *Andrena vaga*, collected along an urbanisation gradient. Our data will allow the assessment of the importance of certain urban habitats for gene flow and facilitate the identification of dispersal corridors between populations that may promote gene flow and prevent the loss of genetic diversity in *Andrena vaga* urban populations. Such knowledge will inform conservation management to mitigate the potential negative effects of cities on this oligolectic bee species.

More than stones and spines – Formulation of a management concept by means of habitat and species surveys for the degraded dry grasslands at the Lower Austrian Spatzenberg.

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Abandonment of land use is a major driver for the decline of dry grasslands and xerothermophilous species in Austria, including the Lower Austrian Spatzenberg ("sparrows mountain"). Until the 1970 s, the southern slope of the Spatzenberg was grazed and partly used as a vineyard. Due to the abandonment of (extensive) agricultural use, a high proportion of the calcareous dry grasslands are now isolated and dominated by woody plants. Qualitative and semi-quantitative species surveys, especially of the taxonomic groups butterflies, grasshoppers and flowering plants, are to determine which species relevant for nature conservation are still present on the remaining areas. Based on the historical distribution of the dry grasslands and the current potentials, a management concept will subsequently be developed to maintain and increase the habitat for the xerothermophilous biocenosis. Since most of the surveys will not be conducted until later in 2022, only preliminary results are available to date. So far, 110 species of flowering plants and 15 species of butterflies have been detected. It was noticeable that although many typical dry grassland species still occur, they are limited to small areas or populations. From this it can be deduced that the restoration of open habitats with heterogeneous ecotones is crucial.

Ecosystem services concept in national park planning: factors influencing the inhabitants' perspectives on local natural resources and protected areas

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Despite changing paradigms on nature conservation, protected areas (PAs) such as national parks (NPs) remain key elements of systems of nature protection worldwide. Nowadays PAs are seen as socio-ecological systems and there is a belief that using ecosystem services (ES) approach may help explain social reluctance towards planned or existing PAs. In the study, we focused on the planned Turnicki National Park (TuNP), in the far eastern part of Polish Carpathians, which since the 1980 s has been an arena of intensive environmental conflict between proponents of park establishment and local stakeholders. We examined the use of the ES lens in explaining opinions towards the planned TuNP using a questionnaire survey covering municipalities nearby the proposed TuNP. We found important associations between attitudes towards parks and different factors. The main differences were related to age, the length of living in a municipality, level of education, and net income. Most notably, respondents who saw the benefits of nature were more positive towards NPs (and TuNP), and those who prioritized provisioning services were more skeptical. The study has shown that using the ES lens can help explore the factors important in the establishment and management of PAs and improving people's attitudes towards PAs.

Changing assembly rules during secondary succession

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According to theoretical considerations, at the beginning of succession – after getting over the dispersal limitation stage – community composition is primarily shaped by environmental filters (generating functional convergence), while in later stages limiting similarity (generating functional divergence) will be dominant. However, empirical evidence does not clearly support theoretical expectations. Changes in vegetation composition were evaluated by a combination of time series and space-for-time substitution: conducting three re-

surveys of permanent plots on four old-field age-groups.

We detected a non-random pattern for each trait in at least some part of the succession. Departure from randomness did not change significantly over time for six traits: seed mass, lateral spread, and pollination type were divergent, while leaf size, generative height, and length of flowering were convergent. Six traits showed changing patterns along the succession. Four of them showed increasing divergence (e.g. dispersal type, LDMC), which supports our hypothesis. While two (SLA, life form) displayed increasing convergence, contrary to expectations.

We confirmed the general hypothesis that convergence is predominant initially and that divergence can be detected later in succession for four traits. However, the large variation found in trait dispersion indicates that complex processes operate during succession.

Natura 2000 Forest Habitats Management model in Lithuania

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The concept of Natural forest habitat management in Lithuania for Natura 2000 areas has been developed. Currently management activities in Natura 2000 areas are suspended, even though some habitats require urgent active management to maintain their values.

Natural habitat types were divided in two categories: (I) Unique, not abundant and sensitive habitats, and (II) More wide-spread and typical for the region habitats. Management planning for category I habitats should be limited to stand level (conservation management, forest protection and growth measures); category II – planning is expanded to the landscape level imitating natural dynamic.

Conservation management includes the control of invasive species, forest density and structure management, elimination of undergrowth, prescribed burning, restoration of hydrological regimes, control of negative beaver impacts, inhibition of unfavourable succession.

Forest protection and growth measures applied are very limited under critical situations: stand sanitary control, thinnings, regeneration, wildlife damage prevention. These measures must support and improve the habitat conservation status.

Forest natural dynamics imitation is planned on a whole protected area level (landscape) and includes single trees (0.05 ha), small gaps (<0.25 ha) and large gaps formation (0.25–1.0 ha). Depending on light sensitivity of successional tree species, stand cover of 20–40% canopy must be retained.

Network of forest habitats of European importance in Latvia – mapping and analysis, and conservation strategies

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Mapping of forest habitats of European importance in Latvia (EU boreal biogeographical region) was conducted in 2017–2021, with the aim to determine their distribution and quality. A total of 274 experts participated in field survey, all of whom participated in training and calibration sessions. Experts were given maps with obligate areas to survey (identified from the forest register and other sources). In the field, identified forest habitats were mapped and information on structures, processes and species were entered on the standardised data forms. The area of mapped forest habitats was 334597 ha (9% of total forest area). Only 29.7% of this area is in the Natura 2000 network and only 4% of the total forest area in Latvia is strictly protected. Therefore, there is great need for improving conservation strategies, based on quality parameters of the habitats. As the next step, within the LIFE-IP "Optimising the Governance and Management of the Natura 2000 Protected Areas Network in Latvia" (LIFE19IPE/LV/000010), multivariate analysis of the data was used to determine clusters of associated structures, processes and species. Dead wood was a key factor related to disturbance types and indicator species, but depended on the forest type.

Short-lived species move uphill faster under climate change

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Climate change is pushing species ranges and abundances towards the poles and mountain tops. Knowledge of general patterns at a large spatial scale, such as a whole mountain range, is scarce. From a conservation perspective, studying wildlife altitudinal shifts is relevant because mountains often represent biodiversity hotspots and are among the most vulnerable ecosystems. Here, we examine whether altitudinal shifts in birds' abundances have occurred in the Scandinavian mountains over 13 years, and assess whether such shifts are related to species' traits. Using abundance data, we show a clear pattern of uphill shift in the mean altitude of bird abundance across the Scandinavian mountains by 0.9 m/year. Out of 76 species, 7 shifted significantly their abundance uphill. Altitudinal shift was strongly related to species' longevity: short-lived species showed more pronounced uphill shifts in abundance than long-lived species. These results suggest that uphill shifts are not only driven by a small number of individuals at the range boundaries, but the overall bird abundances are on the move. Overall, the results underscore the wide-ranging impact of climate change and the potential vulnerability of species with slow life histories, as they appear less able to timely respond to rapidly changing climatic conditions.

Linear structures affect spatial turnover of pollinator communities in a landscape scale

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Landscape composition and spatial configuration of habitat patches are important determinants of biodiversity in fragmented semi-natural habitats spread across landscapes. However, little attention has been paid to man-made structures that can moderate spatial processes affecting pollinator communities. In a large-scale study, we explored the importance of railway embankments and levees for the turnover of pollinator species and plants in a landscape scale. We sampled pollinating insects and plants, at 55 study sites located along railway lines and levees. Control grasslands included 39 patches in which pollinators and plants were sampled. We assessed the relationships between dissimilarity and distance for pollinators and plants using Moran's Eigenvector Maps. The dissimilarity for pollinators on railway embankments was spatially structured: sites that were closer together were also less dissimilar in their community composition than more distant ones. Dissimilarity was also spatially aligned for plants on levees. The species dissimilarity of pollinators and plants was not spatially structured on grasslands. Our study highlights the potential function of linear structures as corridors for pollinator and plant populations. Landscape managers should include railways and levees in green networks to improve spatial processes linked with the distribution and turnover of pollinator and plant species.

Impact of 2019–2020 summer season fires on the mammals and birds habitat in Australia

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Australia has been affected by devastating forest fires during the 2019–2020 summer season. They began in June 2019 and continued until the end of February 2020, killing billions of animals and destroying their habitat. Here, we quantify the loss of habitat for Australian forest mammals and birds due to fires. We also assessed the potential change in their threat status using the IUCN Red List criteria. In particular, we evaluated the loss of habitat in relation to different environmental variables: management zones, protected areas, and

accessibility. We created a burnt areas map, and we overlapped it with species' habitat models. Through a mixed logistic regression model, we modeled the effect of the three environmental variables on the percentage loss of habitat. Our results show that the majority of species experienced fires within their habitat, and at least 10 mammals and 6 birds could have potentially deteriorated in conservation status.

The most impacted region was located in the South-East of the Continent. Notably, Wilderness Areas (Ib category) lost on average 50 % of their habitat. The fires spread especially in remote areas, more difficult to access, where the detection of fires and the intervention could have been less rapid.

Wildlife monitoring by AI: How far are we?

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Camera traps are essential for most biodiversity-motivated studies. However, periodically processing the high number of generated images is a tremendously tedious and time-consuming task. Our work helps to overcome that aspect by developing new technologies that allow a deeper understanding of data from camera traps. Our system achieved accuracy over 97% in filtering empty images, performing similarly or better than human annotators. While evaluating the system's performance, we achieve outstanding accuracy in the following scenarios: (i) 85% in recognition of 275 species on a dataset provided by Wildlife Conservation Society (WCS) and captured over 552 locations spread across 12 countries, (ii) 95% in recognizing 53 species groups from Serengeti national park, and (iii) 95% on a common species in central Europe. The technology developed through our work can significantly increase annotation functionality, especially to improve and simplify the identification of individuals and refine population estimates of endangered species. When used on large datasets, the system can reveal new relationships in the indexed data over time and across diverse locations. Moreover, the methods and tools developed here can be applied to improve invasive species monitoring.

A content analysis of UN agency strategic plans: where are the gap and opportunities for addressing biodiversity goals?

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The conservation and restoration of biodiversity have become increasingly recognised as foundational for achieving the United Nations Sustainable Development Goals (SDGs). This recognition has prompted the UN to re-think its system-wide approach to biodiversity, with plans to enhance the integration of biodiversity goals across the work of UN agencies. However, the specific mandates and set resources of each agency means it can be difficult to integrate biodiversity in a way that promotes synergies and minimises trade-offs. We, therefore, aimed to analyse the extent and context in which biodiversity goals are being integrated into the plans of a sample of core UN agencies by conducting a content analysis on their 2022–2025 strategic plans. Each document was coded in Nvivo using a set of pre-determined key terms relating to the biodiversity-related SDG targets as well as identified synergies and trade-offs between these goals and other SDGs. The content quality (how often a term or word occurs) and the relational qualities (in what context a term is used) were analysed to produce a summary of biodiversity integration for each agency. The findings of this study highlight the current opportunities and barriers to creating a transformative change for biodiversity across the UN systems.

Effort to maximize bird species richness may favour common forest birds over threatened farmland birds in midfield woodlots

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Non-productive habitats are essential to prevent further biodiversity loss caused by agricultural intensification. Woodlots, the small patches of woody vegetation in agricultural landscapes, are one of such habitats currently subsidized by the EU's Common Agricultural Policy but still poorly studied. Our aim was to find out what implementation of woodlot vegetation is the most beneficial for birds in farmland. We measured habitat characteristics (describing vegetation structure, diversity and nativeness) and structural characteristics (area, shape and isolation) in 82 midfield woodlots in Czechia (Central Europe). Then, we related these characteristics to species richness of all birds and two guilds most frequent in woodlots: forest and farmland birds. After accounting for the effects of structural characteristics, overall bird species richness increased with vegetation height and species richness of woody plants in woodlots. Also, it showed a non-linear decrease with cover of an invasive tree, the Black Locust. Forest bird species richness was related to the same habitat characteristics whereas farmland birds were positively related to microhabitat diversity. In conclusion, if the management aims to maximize the overall bird species richness, which can be achieved by high and species-rich woody vegetation, it will rather favour widespread forest birds instead of disappearing farmland birds.

The necessity of full coverage field surveys in fine-scale planning of conservation actions in a highly mosaic habitat complex

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Spatially realistic and up-to-date field data is a crucial basis for conservation planning and long-term management. As part of the OAKEYLIFE project (2017–), we conducted full-coverage surveys on invasive alien tree species (IATs) and habitats in a 1000 ha forest-steppe complex in the Peszér Forest (Central Hungary). Instead of sampling, IATs were mapped in a 25x25 m grid that thoroughly covered the area with a total of 16,000 survey units. Habitats were mapped on patch level (based on aerial photo interpretation) instead of the widely-applied forest subcompartment (a.k.a. smallest forest management unit) level, which resulted in 1000 patches in 300 sub-compartments. Both these high-resolution maps proved to be essential in decision making, i.e. to be able to decide where to carry out reconstruction (e.g. clear-cut followed by artificial reforestation in the case of patches characterized by high abundance of IATs and low conservation value) or rehabilitation (e.g. selective chemical treatments in the case of patches characterized by lower abundance of IATs and higher conservation value), identifying no-go patches for economic forestry interventions, establishing buffer zones, etc. However, the effort required for such surveys must be taken into account – which in our case exceeded 700 days.

Urban Digital Twins: new tools for the analysis of urban greening

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Digital Twins are 3D virtual representations of real-life physical systems, equipped with analytic tools and simulation models to study and test changes in the physical system. The growing use of Urban Digital Twins in urban planning, and the growing importance of the provision of Ecosystem Services in cities, have created a demand to develop digital twins also for urban nature. We develop digital plants and green area biomes, whose outlook, properties and temporal development can be parameterized based on empirical evidence or

expert estimates. We also explore the potential benefits of utilising Urban Digital Twins in the planning of biodiverse and connected urban green areas. Thanks to their three-dimensional nature, and the potential to provide an immersive user experience with the help of game engines, urban digital twins can provide an inclusive platform for citizens to compare alternative green area plans, view information on their biodiversity (effects), and test green area plan resilience in different future scenarios. Digital twins of urban nature could also be developed to allow private landowners to test how their properties could contribute to the biodiversity of their surroundings.

Melanism in *Natrix natrix* (Linnaeus, 1758) from Danube Delta Biosphere Reserve, Romania

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Animal coloration has a significant ecological role in defense, reproduction, and thermoregulation. Skin melanin varies in quantity, leading to continuous intraspecific polymorphism in wild populations. Melanistic individuals have certain physiological advantages in the ecological context: to preserve their body temperature more efficiently. *N. natrix* (Common grass snake) is distributed in central, southern, and eastern Europe and western Asia. *N. natrix* is one of Romania's most common snake species and is highly detectable in suitable habitats; and has a wide range of color polymorphisms, from olive to grey and melanistic. The melanistic morph in *N. natrix* from the Danube Delta Biosphere Reserve (DDBR) has been previously recorded. However, to which extent this morph is distributed/common in DDBR is unknown. Between 2016 and 2021, we conducted field-work in DDBR and observed *N. natrix* individuals with complete/partial melanism in 5 localities, suggesting that the melanistic individuals are widespread. We observed both juveniles and adults with melanism (n=11; snout-vent length from 185 to 870 mm), suggesting that individuals are born melanistic. The extent to which melanin concentration is plastic is unknown. Likely, in DDBR, the melanistic morph has a thermoregulatory advantage by reaching their physiological thermal optimum even when hiding from and avoiding predators.

Effect of mowing on snail communities in wet meadows of Northern Hungary

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Wet meadows are usually harbouring high biodiversity and hence are important habitats across the globe. These places are typically utilized by grazing or mowing in order to produce forage. Nevertheless, regular mowing may significantly affect attributes of these habitats and hence may seriously impact populations of their species. To investigate the effect of land management practice we compared snail communities of mowed and unmowed wet meadows. Our study was implemented in the Putnok- and Cserehát Hills in North-Hungary. The abundance, number of species and diversity were taken into consideration as traits of the snail communities. We used linear mixed effect models during the analyses of data. We found that mowing decreased both the number and diversity of species, but abundance was not affected detectably. Our results suggest that regular cultivation on wet meadows may negatively affect the snail fauna. In case of regular land use, it is important to maintain uncultivated patches on those parts of the meadows, where conditions are most resembling the original to facilitate resettlement. Prepared with the professional support of the Doctoral Student Scholarship Program of the Co-operative Doctoral Program of the Ministry of Innovation and Technology financed from the National Research, Development and Innovation Fund.

Threat of common juniper trees by invasive small cypress bark beetle *Phloeosinus aubei* in the Czech Republic

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The small cypress bark beetle *Phloeosinus aubei* is considered an invasive pest in several central European countries, and we have determined its current distribution on common juniper trees (*Juniperus communis*) in the Czech Republic. The results indicated that *P. aubei* is widely distributed in the country but is more common in the east than in the west. The beetle was mainly detected on older, damaged trees and on stems with diameters > 3 cm. The apparently widespread and abundant populations of *P. aubei* could explain infestations of the beetle on *Thuja* spp., *Cupressus* spp. and *Juniperus* spp. in gardens and parks (four confirmed cases during the last 10 years). We consider *P. aubei* to be a potential pest on older, naturally occurring *J. communis* in protected areas where its population density could increase on weakened and damaged trees by game. We suggest that *P. aubei* can be monitored via simple inspection of dying and dead *J. communis* trees in the field.

Catch me if you can: Mitigation of Common Myna (*Acridotheres tristis*) presence and activity in protected areas

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The common myna is designated by the IUCN as one of the 100 most harmful invasive species in the world. A dramatic increase in myna populations throughout Israel in recent years poses a severe threat to the local biodiversity. We examined the effect of an intensive trapping campaign, conducted for the first time in Israel, on myna abundance and vigilance inside protected areas (Ramat Hanadiv nature reserve as a case study). We recorded myna presence and flight initiation distances (FID) in Ramat Hanadiv and in one reference site before and after the trapping campaign. In July–August 2021 we trapped 105 mynas in Ramat Hanadiv (69 adults and 36 juveniles). We found that myna abundance in Ramat Hanadiv significantly decreased after trapping, while a significant increase was seen in the reference site. Mynas were rarely seen in the reserve after trapping and their removal was effective for 7 months. Mynas' FID inside the reserve significantly increased after trapping, indicating increased vigilance. The results suggest that intensive trapping causes a significant decrease in myna numbers inside protected areas, causes a behavioral change, and can assist in myna management in protected areas in Israel and elsewhere.

Climate change and microrefugia: the refugial capacity of dolines in the Mecsek Mountains (Hungary)

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Climate change has considerable impacts on ecosystems. Plant species can retreat to safe havens (i.e. microrefugia), where they can persist despite unfavourable macro-environmental changes, such as global warming. Enclosed depressions of karst landscapes (i.e. dolines) may act as such microrefugia for many cool-adapted species. We studied the vegetation, soil and microclimate in 12 larger dolines (sites: south-facing slope, north-facing slope, and bottom) and the surrounding plateau sites in the Mecsek Mountains (Hungary). We determined the diagnostic species at each site, and used distance-based redundancy analysis to analyse the relationships between vegetation and environmental variables. We found that differences in abiotic conditions and compositional differences in vegetation were most pronounced between doline bottoms and the plateau. Most of the measured soil parameters reached the highest values in doline bottoms. The results also showed that doline bottoms provided the coolest and most humid microhabitats within dolines. Despite the warm and relatively dry summer, the soil moisture in most doline

bottoms had remained relatively stable in the investigated period. These results suggest that doline bottoms in forested landscapes have the potential to provide not only climatic microrefugia but also important hydrologic microrefugia during global warming.

Global distribution of saproxyly in birds

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Saproxylic species largely suffer from the degradation of forest habitats, which is possibly to exert strikingly negative effect on global biodiversity. Yet, it remains unknown since the variation and prevalence in saproxylic dependencies has never been summarized from the global perspective. Here, by reviewing scientific literature and investigating global handbook of birds Aves, we for the very first time showed that saproxyly vary from using excavated, fungi- or abiotic-formed tree holes (mainly in dead standing trees) or uprooted trees, foraging on invertebrates living in various forms of dead wood, bark or wood injuries, arboreal insect nests or epixylic structures, or sucking a sap from wounded trees. We estimated that at least one of these saproxylic dependencies may be attributed to 1706 avian species (~16% of global community). We explore the avian saproxyly in the context of state of knowledge, taxonomy, geography and discuss an implications of our findings for the future of global biodiversity.

Fistful of Data: Information sources on Czech biodiversity monitoring and mapping, their integration and use

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Modern approaches in conservation biology are largely based upon the use of ecological and environmental data. Information about the occurrence and distribution of species and habitats, as well as their underlying factors. The Nature Conservation Agency of the Czech Republic (NCA) currently presents a major driver of collecting and providing ecological data in the country. A large part of the data is collected for the national species and habitat surveillance schemes following a well-defined mapping or monitoring methodology. NCA also integrates the data it collects with external sources, synthesising the information into new data layers like the Consolidated layer of ecosystems of the Czech Republic. The knowledge of information collected and administered by the NCA, its strengths and limits can be highly valuable for both practical conservation purposes and ecological research. As an example of this approach, we present a semi-automatic system evaluating target feature status in the Natura 2000 framework based on the integration of multiple data sources. The framework combines information from the species occurrence and habitat mapping databases with environmental data. Ultimately, the framework is designed to assess the state of species populations and habitats on a site level allowing an effective evaluation of implemented management practices.

Estimating actual abundance of European sousliks: Using UAV imagery, pixel based imaging and random forest classification to count souslik burrows

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The non-invasive estimation of the actual population size of European sousliks or alike is unsolved. Location and number of burrow entrances indicate the area of occupancy and correlate with their abundance. We combined remotely recorded images, pixel-based imagery and Random Forest (RF) classification to identify and count animals' burrows automatically. The spectral distinction between the categories BURROW, SOIL, TREE, GRASS was improved by histogram matching and spectral band normalisation. Both raw and pre-processed

images were analysed by RF classification to compare the change in accuracy metrics of test subsets following a training phase for 4 models including a different predictors. The final model showed an overall accuracy of 91% and Cohen's kappa of 74%. Per-class kappa of precision (K^P_{BURROW}) and sensitivity (K^S_{BURROW}) for BURROW were 95 and 90% respectively. A 10-time bootstrapping of the final model resulted in coefficients of variation (CV%) of K^S_{BURROW} and K^P_{BURROW} lower than 5%, moreover CV% values were not significantly different between precision and sensitivity scores. The consistency of classification results and balanced precision and sensitivity supported the applicability of this approach. This method can help estimate the actual abundance of burrowing mammals and delineate the areas of occupancy more efficiently than traditional approaches.

Assessing the effect of boating regulation zones in Marine Protected Areas on strandings of the Florida manatee, *Trichechus manatus latirostris*.

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Mitigation of watercraft collisions in Florida is vital for the conservation of the threatened species *Trichechus manatus latirostris*. The implementation of boat regulation zones in Marine Protected Areas aims to reduce collisions and protect the species, yet collisions continue to increase per annum. The aim of this thesis was to assess the efficacy of these zones on the reduction of strandings and decipher if there is a relationship between stranding values in and out of boat regulation zones. QGIS was used to compile, MPA, boat zone and fatal watercraft-induced stranding coordinates provided from the Florida Fish and Wildlife Conservation Commission and the National Marine Protected Areas Centre for analysis. Intersections between MPAs and boat zones were run and a points per polygon analysis used in order to determine the locations of strandings. Statistical analysis including 2-way ANOVA was carried out on SPSS between the values of strandings in and out of boat zones per year. Until 2016, strandings were higher in regulated areas, however 2017–2020 values portray higher stranding occurrence in unregulated zones. This data is discussed in relation to its significance to the conservation of *T. m. latirostris* and other species facing the same threat.

Thermal conditions determine lizards' response to oil contamination in a desert habitat

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On December 2014, 'Avrona Nature Reserve, a unique, hyper-arid habitat in southern Israel, was polluted by crude oil from a damaged pipeline. Surveys in the reserve following the oil spill found that some species of local lizards avoid the oil, while other closely related species were found more frequently in polluted plots. These results raised the question: why do these species react differently to oil polluted soil? We examined three lizard species in semi-natural arenas divided into quarters containing natural and oil polluted soils. We placed underground heating pads in clean quarters to simulate dark soil heating without the oil. We evaluated how soil type and thermal conditions interacted to shape lizards' habitat preferences by measuring the time spent by lizards in each micro-habitat. Species responded differently to the treatments. The diurnal *Acanthodactylus opheodurus* was seen less on heating pad when heating was on, perhaps to avoid hot soil during warm hours. Both nocturnal *Stenodactylus* species preferred heating pads when they were functioning. Additionally, *S. sthenodactylus* was seen less on oil-polluted areas, while *S. doriae* showed no preference for any of the other micro-habitats. Our results shed light on the possible impacts of oil spills on ectotherms in desert areas.

Hidden in plain sight: Investigating through the surface web the illicit trade of medicinal products derived from the Indian Spiny-tailed Lizard (*Uromastix* sp.)

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Spiny-tailed lizards are extensively hunted for their meat and fat which allegedly contains aphrodisiac properties. Oil extracted from its body fat is in demand in the South, South-East and Arab countries. Weak regulations and inability of regional authorities to take appropriate action against extensive poaching is leading to over harvesting of the local population. This investigative study explores the transnational nature of the trade and consumer markets. Evidences were collected from YouTube. We identified and analysed 183 videos, 4240 comments and associated content available publicly on this site. 85% of the videos contain hunting and dissecting visuals of spiny-tailed lizard for its oil. Judicious analysis of the video content provides insights into the modus operandi of the illicit trade. The evidence suggest that the videos have been made to reach potential customer internationally. Content analysis of the comments revealed 65% of the commentators exhibit willingness to buy the oil and demand from 20 countries, where India, Pakistan and UAE topping the list respectively.

The unknown journey of birds facing plant invasion

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Plant invaders introduced into heterogeneous lands likely create the relationship between diversified habitats and negative impacts of the invaded area. This research aimed to investigate whether the Caucasian hogweeds impact bird responses by providing niche opportunities or limitations and whether these invaders can be tolerated by birds. Bird and habitat surveys were conducted in south-eastern Poland in 2020–2021 on 112 circle sites with a radius of 100 m, including 32 invaded sites. The abundance of ground/herb dwellers dropped with small increases of the invaded area. Ecotone birds benefited from small invasion mixed with bushes but were negatively affected by severely invaded areas. Large invaded areas were used by bush foragers. Tree foragers preferred partitioning of invaded forests. The availability of habitat opportunities in heterogeneous uninhabited areas was more beneficial for the species richness of ecotone birds, bushes' birds and tree foragers than the surrounding landscape, although invasion reduced this attractiveness. Birds compared between heterogeneous invaded and control areas showed highly negative responses to the invasion resulting from the contrast between enhanced habitat diversity on control sites and the invaded areas. Birds living in the landscape surrounding invasion affected those responses when chose diversified habitats or returned when facing the invasion.

The National Animal Genetic Bank in the Czech Republic – source of biological material available for genetic monitoring and conservation research

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As the loss of Earth's species has accelerated, the importance of preserving biological material has grown significantly in recent decades. Collections of genetic samples may not only serve as evidence of (previously) existing biodiversity but also enable the monitoring of changes in genetic diversity in space and time, and thereby help answer questions on the causes of threats or extinction in specific populations. In this way, they can effectively contribute to species conservation. Moreover, current considerable technological advancements have meant that molecular genetic methods are gradually becoming a routine tool available also for conservation biology. As a source of

material for conservation genetic studies we offer samples of the National Animal Genetic Bank (NAGB) network that brings together two members' collections with publicly accessible sample data. More than 17 000 samples are at present available (IVB and CUNI repositories at GGBN Data Portal), representing vertebrate species from 18 countries and four continents. As NAGB does not only provide samples but also accepts them, it provides an opportunity for those who come into contact with wild animal carcasses to contribute to species conservation. NAGB is financially supported by Strategy AV21 of the Czech Academy of Sciences and INTER-EXCELLENCE – INTER-COST (LTC20021).

Comparative analysis of anthropogenic and natural factors influencing visitor's load in 20 Estonian nature trails

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The popularity of nature tourism is increasing the visitation to the nature trails. The visitor's load is affected by various factors that trail's infrastructure or natural environment offers to the visitors. Therefore, it's relevant to know which factors are influencing visitation rates in order to manage the trails more effectively. The purpose of our study was to make a quantitative comparison of which nature trails factors are best correlated with the visitor's load on 20 nature trails in Estonia. Data was collected during fieldwork between May–August 2019, visitor's load data was requested from the State Forest Management Center. The model of the factors was constructed in two steps: first a correlation matrix with all the factors, then a generalized linear model for comparing the relative effect of the factors. Significant correlations were found between visitor's load and distance to the nearest county center, nearest possibility for catering, nearest bus stop, number of web and application visits, number of different surface types, number of toilets on the trail, trail species pool, and accessibility by car. The importance of this study lies in the methodologically uniform assessment of both natural and anthropogenic factors influencing trail visitor's load across a whole cultural area.

Environmental Problems and Fishery Management Practices in Hungarian Angling Waters: a Questionnaire Based Survey

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Fishery management related actions of Hungarian angling waters surveyed in our questionnaire-based study. The research was aimed to gather basic information regarding the stocking, water management, water quality protection practices of the fishery managers. Data were collected from 117 angling clubs during 2018. The results highlighted several common non-adequate water management and water usage protocols and numerous environmental problems. Managers (mainly angling clubs) rarely used fish stock assessment data to plan their activities. The spread of invasive species, such as the black bullhead (*Ameiurus melas*) and the gibel carp (*Carassius gibelio*) is increasing, which is major concern for ecological quality, utilization and profitability. Water quality has not regularly been monitored, despite the use of groundbaits not prohibited in most of the cases. Occurrence of algal blooms and oxygen deficiencies were high. Complex examination of the environmental-ecological state of angling waters is necessary to ensure the prosperous fishery management. Regular surveys of fish fauna and registration of water quality parameters should be necessary to develop more precise and sustainable management plans. Continuous monitoring may provide effective preventive tool of different severe events such as fish kills or the invasion of non-native species. This study was supported by the TKP2020-NKA-16 project.

Carrying capacity modelling for conservation translocation: how many West African giraffes can live there?

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Carrying capacity may become critical for successful conservation of endangered species, especially in fragile semi-arid ecosystems where climate change is particularly pronounced. Feasibility studies preceding animal translocations focus on diverse aspects of ecological suitability, but rarely estimate the upper limit of sustaining capacity of the environment, especially for browsers. Our aim was to estimate the browsing carrying capacity of the Sahelian savanna for the West African giraffe (*Giraffa c. peralta*) in the Gadabedji Biosphere Reserve in Niger where conservation translocations were recently initiated. We developed a predictive model to estimate the available browse biomass using processing of aerial images acquired by an UAV and ground-truthing data on tree height and biomass. We recalculated biomass availability to browsing units (using a greater kudu as standard). We estimated available tree biomass for giraffes in the reserve to 145 kg per hectare. One giraffe represents 3.15 browsing units and has an average intake requirement of 4829 kg of dry leaf biomass per year. Estimated browsing carrying capacity of the reserve was 89 individuals in the dry season. We highlight that science-based carrying capacity modelling enable sustainable population management, incorporating population structure and seasonality, and should become an integral part of conservation operations.

Does biodiversity production of High Nature Value farming systems in Europe come at a high environmental cost to the planet?

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Meat consumption and production is a highly contested issue in the field of conservation, due to the displacement and other adverse impacts on biodiversity. Most studies comparing environmental impacts of different production systems exclude biodiversity impacts, and focus on intensive systems. We used data from 41 farms with cattle and sheep that belong to High Nature Value (HNV) farms in six European countries: Finland, Estonia, The UK, France, Greece and Spain. HNV farms are known to support exceptional and some unique biodiversity across Europe. We used Life Cycle Assessment approach to assess the environmental impacts, such as global warming potential, eutrophication, fossil fuels and water use, as well as biodiversity levels. Results demonstrated that HNV farming systems maintain high biodiversity levels, have a potential to act as carbon sinks, reduce greenhouse gas emissions, nutrient losses and water use, while producing meat. However, a wide range of performance among the HNV farms point out to a need for considerable improvements in their management to reduce the impacts while maintaining high biodiversity. Biodiversity-rich HNV farming systems can play a more central role in transition to sustainable food systems but it will require a drastic reduction in consumption in animal products.

Impact of the traffic noise on bird diversity in the agriculture landscape along the highway

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This research analyses impact of four selected highways in the Czech Republic on qualitative and quantitative characteristics of bird communities. All the highways crossed intensively used agriculture landscape with scattered patches of tree and shrub vegetation. Birds were counted at 298 observation squares 50 x 50 m, which were located at four various distances (25, 125, 500, 1000 m) from four highways across the Czech Republic. In total, 1266 records of birds of 74 species were found. Results from this research confirm negative impact on the bird diversity along highways in this type of agriculture landscape. The bird species diversity significantly decreased towards highway. The fewest species (36) were recorded at the observation squares in the vicinity of the highway with an average abundance of 2,2 records per square. In contrast, observation squares at 1000 m distance reached 61 species with an average abundance of 5,8 records per square. Further, farmland specialists were more affected on longer distance compared to woodland specialists. It's supposed that the main factor causing the decrease of bird diversity is a traffic noise. Spreading of noise is supported by the open agriculture landscape with homogeneous large field blocks that represent a significant threat to biodiversity.

Restoring the connectivity of seminatural grasslands on Muhu island, Estonia. Example of LIFE project „LIFE Connecting meadows“.

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Although the Estonian wooded meadows, alvars and coastal meadows have suffered large decrease in habitat area during past 60 years, most of the light demanding species are still present on sites as remnant populations, occurring on few remaining open spots on each site. However, eventually species richness will start to correspond to current, smaller and more fragmented habitat areas, which results in extinctions of currently present remnant populations. In addition to decreasing habitat area, the increasing isolation of remnant habitat patches have resulted in very low ecological connectivity – they are too far apart from each other to allow necessary seed dispersal between the sites.

In 2019 LIFE project „LIFE connecting meadows“ started in Muhu island, Estonia. Landscape scale planning of the restoration concept is used in the project to plan the restoration of the semi-natural grassland patches to give maximum effect to create connectivity. We demonstrate the importance of metapopulation level in habitat and species protection and the expertise will be distributed and put into further practice also on bigger island – Gotland, Sweden. As a result the model is available to use on the country level.

Factors shaping Yellow Wagtail abundance in intensively cultivated farmland: disentangling the roles of surrounding habitat, field characteristics and food supply

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Farmland birds decline is a well-documented phenomenon attributed to agricultural intensification. However, the specific mechanisms making the intensively used farmland unsuitable for breeding birds have not yet been satisfactorily elucidated. We performed a simultaneous sampling of Yellow Wagtail breeding abundance, invertebrate food supply and habitat characteristics in winter wheat, oil-seed rape and maize fields. Study was carried out in south-western Slovakia – a region characterised by the largest field sizes in the European Union. Yellow Wagtail abundance was best predicted by habitat characteristics: birds chose fields without the woody vegetation

in their surroundings and with a suitable crop height and coverage. The abundance, biomass and diversity of invertebrates were influenced primarily by insecticide applications. Focusing on the studied crops, the birds were not more abundant in the fields with a richer food supply (maize, rape), because these crops had unsuitable vegetation structure. The low overall abundance of the studied species indicates that the environment represented by large fields with a predominance of the studied crops creates unsuitable conditions for its breeding.

Assessing the ecological importance of flowering weeds in agricultural landscapes

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The homogenization and intensification of agricultural landscapes has led to a decline in the abundance and diversity of flowering species (both inside and outside agricultural fields). Because these species provide a wide range of regulating ecosystem services with high values to society, there is a call to restore flowering weed species in agricultural landscapes. To assess the effectiveness of agri-environmental measures to restore biodiversity and ecosystem services, we installed a three-year monitoring program for flowering weed species on perennial self-vegetated fallows, annual self-vegetated fallows and perennial flower fields in an agricultural landscape in Saxony. Our aim is to compare the species richness and functional diversity of the plant communities within these conservation measures. First results show that species richness is highest on perennial flowering fields. However, both annual and perennial self-vegetated fallows have higher functional diversity and provide more regulating ecosystem services than flower fields. Based on this plant survey and the assessment of functional traits, we create a species list that can be used beyond the case study region to practically assess the ecological value of plant communities in flower and fallow fields.

Detection of marine invasive non-native species in a special area of conservation using digital droplet PCR assays and metabarcoding approaches.

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Environmental DNA methods have the potential to enable early detection of non-native species in the marine environment, allowing control and eradication measures to be implemented before non-native species become established. We developed digital droplet PCR assays for four invasive non-native animal species that were identified as high priority for early detection within the Pen Llŷn a'r Sarnau Special Area of Conservation (PLAS SAC), Wales, UK. These were the American lobster *Homarus americanus*, the Chinese mitten crab *Eriocheir sinensis*, the slipper limpet *Crepidula fornicata* and the carpet sea squirt *Didemnum vexillum*. The assays were tested on seawater samples collected from sites within the PLAS SAC, along with samples collected from areas where the non-native species were known to be established. Metabarcoding, using general primers and primers specific to higher taxa of animals, was also applied to the same samples in order to establish the relative efficacy of species specific and metabarcoding approaches for early detection of the target species and to provide additional context in terms of other native and non-native species detected at the sample sites.

Global coordinated study on vegetation changes on nature trails: a call for participation in GetDiv

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Recreation activities and tourism sector are globally becoming more popular. Although people's interest in visiting nature is generally positive, it can also have harmful effects on the biodiversity and vegeta-

tion as the extent and frequency of disturbances grow. Nature trails are basically linear corridors of disturbances. Bringing visitors to fragile and protected areas, as well as constructing and maintaining of trails has an impact on surrounding environment. This could lead to changes in biodiversity and species composition. There have been plenty of studies about tourism impacts on natural areas, however, these have typically focused on local scale (e.g. studying single trails) and flagship species, which means that the methodologies are incomparable, and the data is often based on estimations done on a relative scale. Therefore we have very limited comparable fundamental knowledge on how tourism affects nature, and how similar or different are these effects in different regions, habitats or trail types. Here we present the rationale for the methodological approach, and call for a coordinated global effort – project GetDiv – for collecting comparable and comprehensive data of diverse aspects of nature trails on local, regional and global scale, with the focus on plant diversity.

ibis.iSDM – A modelling framework for creating integrated species distribution models

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Species distribution models (SDMs) are the most widely-used approaches to estimate ecological response functions and create spatial-temporal indicators for conservation and macroecological research. However, many biodiversity data sources are of varying origins and have different levels of confidence. Commonly, existing biodiversity knowledge, such as estimates on species ranges or habitat preferences, is ignored in SDMs, resulting in naive predictions determined by often spatially or environmentally biased data. Here I present the 'ibis' framework for creating Integrated Biodiversity distribution projectionS and specifically integrated species distribution models (iSDM). This new framework supports various levels of integration for different types of data, e.g. polygon, point occurrences and priors from the literature, and likelihood functions such as for presence-absence and presence-only data in Poisson process modelling framework. Further, it is specifically customized to make spatial-temporal projections of future biodiversity trends in response to land-use and climate change.

The ibis.iSDM package is made openly available as R-package and implemented in an object-based fashion. Multiple, predominantly Bayesian algorithms ("engines") and submodules are currently implemented and in the future we plan to expand the framework with additional functionalities, such as submodules and linkages to other tools to account for dynamic response, dispersal and connectivity.

Effectiveness of riverine biodiversity conservation in the Natura 2000 sites: congruent response of micro- & macro-indicator species to habitat loss

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Assessment of the environmental quality of rivers is of urgent need due to habitat loss and accelerating inundations caused by climate change. Assemblages of predatory beetles or bird communities could be used as effective indicators for riverine environments, however, both groups act on different spatial scales. Here, I analyse Carabidae and Staphylinidae along with riverine birds on rivers being under various hydrotechnical alterations and nature protection. The study on 50 river sections in SE Poland in 2021 revealed that there is a high correlation between micro-, and macro-indicators species richness ($R=0.70$), and abundance ($R=0.73$). The diversities of beetles and birds decreased congruently in response to the loss of river channel naturalness. Moreover, both indicator groups showed much higher diversities in sites occupied by Eurasian otter – the flagship species for aquatic habitats (3 and 2-fold more species, 7 and 3-fold more individuals; respectively). Natura 2000 sites sheltered more diverse communities of beetles ($Z=3.25$, $p=0.001$), but not birds ($Z=1.89$, $p=0.059$), which suggests that biodiversity conservation in this net-

work could be improved, especially for the wider spatial scale. This study shows that combined analyses of biodiversity are important for the proper assessment of conservation needs in riverine habitats.

Distribution and population size of the Freshwater Pearl Mussel *Margaritifera margaritifera* (Mollusca: Bivalvia) in Latvia 2020–2021

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The state information system of Latvia lacks up-to-date information on localities and habitats of Freshwater Pearl Mussel *Margaritifera margaritifera*, which prevents the possibility to assess possible threats to species deposits or habitats, etc. The aim of the study was to prepare geospatial information on the *M. margaritifera* habitats and the state of the population to improve the conservation measures of the species. In 2020–2021 the inventory and mapping of *M. margaritifera* in rivers which the species was found during the last ~10 years was performed.

Species populations have been found in 7 rivers. No species found in 4 rivers, but it is likely that the population still exists. The total population is 18650 individuals, forming micropopulations of 15 species in 11 rivers. Populations with a high degree of conservation have been found only in 2 rivers, but the actual situation is worse because the population is fragmented. No small-size specimens were detected. Beaver activity and woody debris in the rivers are the main threats resulting in direct killing of *M. margaritifera* and degradation of their habitats. In addition to the above factors, there are other impact factors, however, their effects are slower or affect only the reproductive processes of *M. margaritifera*.

Lake Koronia, a wetland in gradual recovery process or a flash from the past?

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Lake Koronia, Greece, is a wetland of international and European importance (Ramsar and Natura 2000 site). The lake has deteriorated in terms of habitats, water quantity and quality since 1995, resulting in mass fish and bird deaths. We monitored abiotic and biotic (aquatic macrophytes) parameters between 2015 and 2021 to investigate recovery progress, following implementation efforts of a restoration plan. Abiotic conditions were recorded monthly/seasonally, while vegetation data were recorded in two periods (June 2017, 2020). After an initial considerable increase in water level, mean annual values fluctuated at around 70–71 m asl. Water transparency values were low while conductivity values were high. Three vegetation units were present: Lemnetea, Potamogetonetea and Phragmitetea, represented by few taxa. Helophytic taxa formed a narrow littoral reedbed (< 10 % of the lake area). Few rooted hydrophytes were present but limited to sparse patches (< 5 % of the total abundance). These results indicate that vegetation stabilization or even further expansion could be possible, given that hydrological and physicochemical conditions improve. The possible recovery of this fragile ecosystem depends on both the mitigation of anthropogenic pressures and favorable natural conditions. The continuation of restoration measures and monitoring efforts are considered necessary in this direction.

Light attraction in carabid beetles: Comparison among animals from the inner city and a Dark Sky Reserve

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Nocturnal invertebrates are particularly affected by increasing exposure to artificial light at night (ALAN) due to their fatal light attraction. This selective pressure has the potential to reduce the strength of the flight-to-light response in insects, as shown recently in a moth species.

We investigated light attraction of Carabidae (Coleoptera) and compared among animals from an urban highly light polluted (HLP) grassland and animals collected at a low-polluted area in a Dark Sky Reserve (DSR), Germany, captured using odour bait.

Tested at night, HLP beetles (n = 75, all 3 genera) showed a reduced attraction towards ALAN. HLP beetles were less active in an open field test (latency to start moving), compared to DSR (n = 143) tested during daytime. However, the reduced attraction was not observed in the most common species *Calathus fuscipes* (total n = 155).

Reduced attraction to ALAN in urban beetles may have various explanation and concomitant effects: Result of phenotypic selection, indicating an ongoing evolutionary differentiation. This may directly enhance survival and reproductive success of urban individuals, which again could negatively influence dispersal reproduction and foraging success, highlighting the selective pressure that light pollution may have on fitness, by shaping and modifying the insects behaviour.

The development of a protocol for declaring alien species absent from a country.

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Lists of alien species are important for an accurate account of how many alien species are present in a country. Globally, considerable effort has been made to improve the accuracy of these lists. Species lists should ideally be based on field observations with a physical specimen and whose identity has been confirmed both morphologically and through molecular methods. However, this is often not achieved, and as a result there are numerous errors in such lists. Such errors can inflate species numbers, create confusion, and lead to wasted management effort. We address this issue by creating a framework to guide the process of listing an alien species as absent from a country. The framework is intended to be followed by any entity tasked with responding to a concern raised about the absence of an alien species within a country. This framework was refined via the information brought forward in an expert workshop and then applied to two case study species based in South Africa, namely *Calluna vulgaris* and *Euphorbia esula*, that are listed under national legislation as alien plants and has been reported as present in the country but their presence has not been formally recorded and confirmed and thus disputed.

Effect of community-based forest management on forest structure and multi-taxon biodiversity in the Mayan Biosphere Reserve, Guatemala

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Despite the importance of forest for the maintenance of biodiversity and provisioning of ecosystem services, deforestation is still high or even rising in some tropical countries. Conservation efforts based on strictly protected areas have not been able to counteract illegal deforestation. Community-based forest management (CFM) has emerged as a sustainable model of forest management to reduce the impact on forest ecosystems. In Guatemala, this model is being used in the Maya Biosphere Reserve through a forestry concession pro-

gram since the 1990 s. Currently, deforestation rates in forest concessions are clearly lower when compared to neighboring, strictly protected conservation areas. In addition, the populations of valuable harvested wood species are sustainable. However, the impact of this type of management on biodiversity hasn't been thoroughly evaluated. In this project, we will integrate field measurements, remote sensing (LiDAR and Multispectral), combined with conventional and automated sampling (eDNA, metabarcoding, bioacoustics) methods for plants, insects, microbiome and vertebrates to assess the impact of MFC on biodiversity in the Carmelita community forest concession. Given the global biodiversity crisis and while the Guatemalan authorities are reviewing the MFC model, it is timely and crucial to assess its impact on biodiversity.

Moss-growth assessment reveals that microclimatic edge effects are stronger during drought

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Land use drastically increases the amount of forest edges in the landscape. Edge habitats are likely more exposed to climatic extremes, which could have large impact on the understory biodiversity.

Here we investigated how drought affects microclimatic edge gradients. We used a novel method of retrospectively assessing growth of the moss *Hylocomium splendens* as an indicator of microclimate in space and time. We tested if edge influences varied between a drought year compared to previous years, and if it was the strength or the depth that increased.

Edge influences were nearly twice as strong during the drought year, although they did not penetrate deeper into the forest.

This is likely due to more hours of sun combined with high temperatures, low humidity and desiccating winds during a drought, that penetrate into the forest edge. Thus, reducing the amount of edge habitat becomes even more important under current climate change with more extreme events. Based on our estimations of the depth of edge influence, we propose buffer zones of 20 to 30 meters surrounding forest edges, in order to adapt biodiversity conservation in small forest patches to a changing climate.

Does deadwood origin matter? The way a tree dies affects the trajectories of wood-inhabiting fungal community development in *Picea abies*, especially for very rare specialists.

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We monitored wood-inhabiting fungal communities on 60 spruce logs in different decay stages divided into two classes – (a) uprooted and (b) fallen snags, trees that had remained standing dead (several years to few decades) before falling. Fieldwork was carried out in 2021 at the Boubín primeval forest (Bohemian Forest, Czechia). On each studied log, we conducted both traditional fruitbody-based and eDNA-sequencing sampling. Our preliminary results (based on the former approach) show that the fungal assemblages differ between both classes of the studied trees. The fallen snags served as the preferred substrate for some extremely rare species, such as *Phellinidium ferrugineofusum*, rediscovered in the Czech Republic after 25 years. Also, its successor – the hemiboreal polypore *Skeletocutis delicata*, until now known only known from North Europe and Russia, was for the first time collected in Central Europe on the same substrate. Our findings point to the need for a targeted selection of objects when managing deadwood in forest stands. Not only the total amount of deadwood but also its diverse structure and origins represent key factors for the biodiversity of many dead-wood-dependent groups of organisms.

Nine-year bird community development on a North-Bohemian spoil heap: impacts of vegetation characteristics, restoration approach and human land use

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Despite being valuable indicators of habitat change, birds are rarely used in restoration science. We offer new information by investigating bird community development on a large North-Bohemian spoil heap over a nine-year period from 2012–2021. We performed a sophisticated analysis of community response to site development, human land use (Corine Land Cover categories), primary vegetation productivity, age and structure, proportion of senescent vegetation and restoration approach (spontaneous succession, agricultural restoration, tree planting, etc.). Bird community structure was significantly impacted by specific types of restoration approach (spontaneous succession, agricultural restoration, etc.) or human land use (forest, dump site, pasture, arable land) or vegetation characteristics (tree cover and shrub cover etc.). Bird diversity, rarity and species richness increased significantly as site developed. Bird diversity was significantly lower in dump site and pasture areas than forests or arable land, and increased with cover of the shrub layer. Rarity of birds was increased on spontaneous succession and arable land, in contrast to the low rarity value of forests. The planting efforts on technically reclaimed areas facilitated greater abundances of forest birds and higher overall diversity, but could cause a decline of valuable bird communities by converting extensively managed areas into generic woodland.

Scale-dependence of landscape heterogeneity effects on plant invasions

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Invasive alien species are amongst the most concerning threats to native biodiversity worldwide, and the level of landscape heterogeneity is considered to affect spatial patterns of their distribution. Landscape heterogeneity can be described by its composition and configuration. These may differently affect invasive species and their impacts may be additionally scale-dependent. Yet, their relative contribution to invasion patterns is poorly known. We investigated the effect of landscape composition and configuration across different spatial scales on the abundance of invasive North American goldenrods (*Solidago* spp.). Using a novel method based on inspection of Google Street Views, we collected and analyzed large dataset on goldenrod distribution along 1347 roadside transects in agricultural landscapes of Poland. Both landscape heterogeneity components were positively associated with goldenrod abundance. The effect was most pronounced at the largest spatial scale for compositional heterogeneity, while the pattern was the opposite for configurational heterogeneity. This scale-dependence means that researchers and practitioners may miss the association if only concentrating on a single spatial scale. While increasing landscape heterogeneity is widely introduced as a way to promote farmland biodiversity, we show that it may also support invasive plants. Therefore, we suggest implementing regular management and eradication schemes in most heterogeneous landscapes.

Cataloging Essential Biodiversity Variables with the EBV Data Portal

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We present the EBV Data Portal, a platform for distributing and visualizing EBV datasets. It contains a geographic cataloging system that supports a large number of spatiotemporal description features and enables their discoverability. To facilitate user interaction, it offers a web-based interface where users can (1) share and/or (2) find essential biodiversity spatiotemporal data through intuitive interaction with cataloging and visualization tools. Using the EBV Catalog mod-

ule, the user can explore the characteristics of the data based on the definition of an EBV Minimum Information metadata standard. The Catalog also allows to browse the description of the metadata as both the ACDD standard (JSON) and the EML standard (XML). This enables easy interoperability with other metadata catalogues. An example application is the calculation of EBV summary statistics for selected countries and areas. Using the EBV Data Portal, users can select EBVs and calculate basic biodiversity change metrics from spatiotemporal subsets and visualize conveniently complex, multidimensional biodiversity datasets. These visualization and analysis tools of the EBV Data Portal are a first step towards an EBV-based dashboard for biodiversity analyses.

HABITAT SELECTION MODELING TO ASSESS DRIVERS OF HABITAT LOSS IN WILD REINDEER

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Terrestrial biodiversity is declining rapidly from human land uses and associated landscape changes. In Norway, fast-paced anthropogenic development threatens Europe's last wild reindeer (*Rangifer tarandus tarandus*) herds hosted in southern country, which are primarily impacted by consequent habitat loss and fragmentation. In order to help land management towards the protection of suitable and ecologically functional habitats for the species, we developed a quantitative and spatially-explicit framework based on resource selection functions (RSFs) to assess the main drivers of habitat loss. Our results revealed substantial habitat loss (> 50%) in most herds, with major drivers of habitat loss being unevenly distributed within the study area. Overall, highest disturbance levels were caused by grazing animals from domestic livestock, houses, roads and hiking trails. These results point out the need for prioritized and targeted mitigation of herd-specific drivers of habitat loss, and provide key insights for preventing future human-reindeer conflicts. More widely, we show that RSFs can deliver timely information and practical support to land management and conservation strategies. Our approach provides a valuable framework for assessing habitat loss, scalable to many other biodiversity components, and thus offers potential to address this leading cause of species extinction worldwide.

Effects of amusing memes on concern for unappealing species

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There is limited knowledge of the mechanisms that can inspire people's concern and engagement in the protection of unpopular and unappealing species. We analyzed Polish people's interest in themed internet memes featuring the proboscis monkey (*Nasalis larvatus*) and the consequences of this interest for conservation marketing. We examined Google Trends data, used Google Search, and searched popular media materials to estimate interest in the proboscis monkey in Poland. Photos of the proboscis monkey when presented with humor in internet memes attracted as much interest as usually more popular species (e.g., koala, panda, and orangutan) used in marketing by nongovernmental organizations. Amusing internet memes spread by social media positively correlated with increasing interest in the unappealing species, such as proboscis monkey. Interest in amusing internet memes positively correlated with individuals' decisions to donate to 6 crowdfunding actions. Thus, conservation marketing that includes amusing memes and social media may provide a worthwhile complement to traditional campaigns and are likely to influence individuals who are unaffected by the usual means.

The effects of forest age and slope aspect on the refugial capacity of karstic microrefugia

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Topographic depressions of karst landscapes, such as dolines, may provide important microrefugia for species sensitive to climate change. Their refugial capacity may be affected by anthropogenic disturbances, such as forestry activities. We studied the combined effects of forest age (class 1: 5–10-year-old stands with mature forest patches, class 2: 40–45-year-old stands, class 3: 60–65-year-old stands, and class 4: more than 90-year-old stands) and slope aspect (microhabitats: N-facing slope, S-facing slope, and bottom) on the plant species composition of dolines in Hungary. The different groups of plant species – beech forest species, oak forest species, and species of disturbed forests – usually showed significant preferences for certain microhabitats within the forest age classes. In general, the number of plant species in all studied groups increased after a few years of canopy removal. However, the number of plant species in almost all groups was lower in class 2 than in the other age classes. Doline bottoms in class 4 provided suitable environments for more beech forest species than doline bottoms in the other forest age classes. Our results may aid in the understanding of the effects of forest management on the function of microrefugia in karst landscapes.

Variations in home range size of puma (*Puma concolor*) across the distribution range: effects of productivity, diet and competitors

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The home range size of wildlife species is an important ecological trait of importance for the demography, viability and conservation of their populations. Home range size is determined by a combination of abiotic and biotic factors that are best contrasted and explained when evaluated across the entire distribution range of the species. The puma (*Puma concolor*) is a generalist predator widely distributed in well diverse environments. We modelled the determinants of the home range size of pumas by collecting data from local studies and combining macroecological variables (climate, seasonality) with others on interspecific competitors and prey type. Modelling results revealed that the home range size of pumas was positively associated with the percentage of small mammals in their diet and increased seasonality of precipitations. Also, the presence of the jaguar (*Panthera onca*) was related to a higher percentage of small mammals in the diet of pumas, and thus, to an increase in home range size. A higher seasonality due to global warming could increase the home range size of pumas, thus reducing the density of their populations. This potential scenario could put some puma populations at risk, and could be particularly pronounced in areas of sympatry with the jaguar.

Testing the predictive performance of comparative extinction risk models

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Comparative analysis of extinction risk allows predicting species-level risk from the complex interactions between intrinsic and extrinsic drivers. Many analytical techniques have been used for this purpose, but have never been compared. Using amphibians as a study group, here we test and compare the predictive performance of four different techniques (i.e., Cumulative Link Models, Random Forests, PGLS, Neural Networks). We used species traits, spatial descriptors, and proxies for climate change and land use as predictors to calculate the IUCN Red List category. We found that Cumulative Link Models and Random Forests performed better than PGLS and Neural Networks,

and that all four models agree on the identification of 86.18% species as threatened/non threatened. The most important predicting variables across models were species range descriptors, climate, climate change and land-use change. Comparing current IUCN Red List category with the ensemble prediction of the four models, we identified species that should be prioritised for future assessments as species listed in a lower threat category than the predictions. We propose ensemble predictions as a promising tool for prioritising species for reassessment while accounting for models' uncertainty, based on their most likely conservation status considering trait and extrinsic information.

Importance of old-growth forests for wood-inhabiting fungi

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Old-growth forests represent an important refuge for forest biodiversity. Forest exploitation associated with increased demand for timber has led to significant changes in the structure of forests, which have mainly affected saproxylic species dependent on dead wood. Wood-inhabiting fungi are among the most affected forest taxa, despite their enormous importance in the ecosystem. They require sufficient quality and quantity of dead wood and its continuity and are sensitive to habitat change. In order to find out which structural parameters related to the age of the forest stand are important for the diversity of wood-inhabiting fungi, we established 30 permanent research plots in the old-growth mountain spruce forest in Jeseníky Mountains (Czech Republic). We measured the structure of dead wood (volume, dimensions, decay stages, substrate types) and forest age using a dendrochronological approach. During the mycological survey, we recorded 149 species of wood-inhabiting fungi, of which 10 species are red-listed. As a result of long-term natural development, there are specific structural elements (e.g. old trees of large dimensions, standing and lying dead wood of various decay stages) that are important for fungal diversity and should be mimicked in managed forests to preserve biodiversity.

The role of flagship species and certifications in a wildlife-friendly farming label

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Wildlife-friendly labels have been employed to enhance biodiversity conservation through market mechanisms. The present study evaluated consumer preferences for each certification type of wildlife-friendly label by using an online choice experiment for rice consumers in Japan. We designed a scenario in the CE that provides a hypothetical certification with additional features: certification methods; target species of labels; statements about donation mechanism; rice price per 5.0 kg. The results show that, by itself, information regarding wildlife-friendly farming certification does not affect consumer preferences. However, combining each certification type with target species labeling significantly raised consumer preferences for wildlife-friendly rice. We also found consumer preferences for each certification type differ depending on the species. Consumers preferred outcome-based certification with fish labels; on the other hand, they preferred input-based certification for bird labels. Moreover, most consumers preferred the label to include a donation mechanism. The marginal willingness to pay for the donation mechanism statement was 588 JPY. The different preferences for each certification type with target species highlight the importance of strategic certification and labeling in encouraging biodiversity conservation. The findings also highlight the potential role of conservation marketing in enhancing agroecosystem conservation.

Do linear structures support diversity of pollinators and plants in a human-modified landscape.

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Valuable habitats in various spatial configurations are essential for maintaining biodiversity across highly fragmented landscapes. In a large-scale study, we explored the value of human-made linear structures— railway embankments and river levees – as valuable habitats that support large populations of pollinators and plants. The most significant spatial variables affecting pollinator and plant populations on embankments and levees were also examined. Species richness and abundance of bees and butterflies were about 40% higher for railway embankments than for control grasslands. The richness of native plant species was about 25% greater on levees than on control grasslands. The most important landscape factor affecting pollinators was high shrub density which decreases the richness and abundance of pollinator species on linear structures. Specific conservation strategies involving linear structures should focus mainly on preventing habitat deterioration due to encroachment of dense shrubs. Thus, linear structures and their correct management may be a good example of man-made alterations in the environment that meet the demands of both civilization and biodiversity conservation.

Analyzing possible pathways to align biodiversity conservation with agricultural development in Tanzania

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Tanzania has extraordinary rich biodiversity together with high ongoing agricultural expansion and great potential for agricultural intensification. However, both agricultural expansion and agricultural intensification could have adverse effects on biodiversity.

This study seeks to evaluate how an increase of crop production would impact biodiversity in Tanzania. Additionally, synergies and trade-offs with other ecosystem services, such as climate change mitigation will be investigated. Furthermore, the research aims to explore how a change in crop production in Tanzania would impact the agricultural markets.

To our knowledge, the degree to which cropland can be expanded or to which current cropland use can be intensified (ignoring and taking biodiversity objectives into account) is not known. Therefore, as a first step of the research process, we set up a questionnaire targeted towards local and international biodiversity and agricultural experts.

The results from the questionnaire will be utilized to change assumptions on productivity and agricultural land for crops in the IFPRI IMPACT model in order to simulate impacts on the Tanzanian economy. The modeling exercise will show potential pathways for a sustainable food supply in which biodiversity protection is taken into consideration.

Aquaculture of Asian fish species *Ctenopharyngodon idella*: prospects for adaptation in Eastern Europe in the context of climate change

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Recently, the studies of the emergence of invasive aquatic species in aquaculture, for example herbivorous *Ctenopharyngodon idella*, are of particular importance since their naturalization may be more successful due to climate change. Using GIS-modeling, we found that potentially suitable areas for *C. idella* are located up to 48°N. The fac-

tor “Annual mean temperature” was found to have the biggest contribution to the model (29.5%) as juveniles’ reproduction and growth depend on warm water. Until 2040 it is quite a promising object of aquaculture for the Baltic and Scandinavian countries. Taking this into account it is possible that the range of this species will shift northward to 52–55°N. Therefore, it is necessary to consider such aspects of the species adaptation as: their impact on local biodiversity and how the environment affects them. Herbivorous Asian fish species probably don’t pose direct considerable threat to native European fish or herpetofauna, nevertheless they can lead to the alteration or loss of habitat for native water species; also, in pond aquaculture they can purify aquaculture ponds overgrown with vegetation and will be food for turtles (*Emys orbicularis*). We thank for cooperation the BiodivERsA and Water JPI project „EMYS-R” and FLPP project Nr.lzp-2021/1-0247.

Global patterns in human tolerance by birds in the Anthropocene

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The Anthropocene is characterized by rapid and extensive anthropogenic alterations of natural ecosystems. Human-driven environmental modifications are typically seen as significant threats to the global biodiversity but complex and often non-trivial interactions may emerge between wildlife and humans in novel environmental settings. This is an urgent call for research that can be directly translated to wildlife management practices. Recent studies indicate that a level of tolerance of animals towards humans may be one of key mechanisms facilitating wildlife–human coexistence. However, available studies ignore a large portion of the global variance in this trait. We are exploring global patterns in tolerance of birds (Aves) toward human disturbance (measured as flight initiation distance), where we ask: (1) which life-history and environmental variables affect avian tolerance; (2) whether avian tolerance differs between geographic regions and taxonomic groups; and (3) how human activity (e.g., urbanization and human density) affects avian tolerance. Ultimately, through this project, we aim to bring together numerous scholars and enthusiasts from around the world and create an international, diverse and inclusive web of collaborators.

Effects on biodiversity from the extractive and non-extractive use of medium and large sized mammal species.

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Many human activities impact species directly through either extractive (e.g., hunting) or non-extractive (e.g., nature tourism) uses. Both, cause impacts along a gradient, making neither use fully sustainable nor unsustainable. Medium and large-sized mammals are important for these activities, and effects on population demography are reasonably well-studied, making them a promising study-system to assess these impacts.

I will address three questions to explore how extractive/non-extractive use affects biodiversity: How are species’ populations and richness affected by use on a global scale? How are these effects influenced by biogeography, ecology, and human-perception? Is “use” a long-term conservation driver?

For this, I will conduct a metaanalysis from published and grey literature on species’ populations, and evaluate the impacts resulting from use, this will be complemented with a paired-design evaluation (extractive vs. non-extractive), using specific case-studies. A geographic analysis will help to understand how the results from the meta-analysis are distributed across the globe.

I aim to better understand the conditions under which use can be sustainable, and to translate this into recommendations for conservation practice. This approach may be important for biodiversity-rich but economically impoverished regions that could rely on biodiversity as a mean of development amidst the current biodiversity crisis.

Survival of adult lynx females – research of population threats in the center and at the outskirts of the Bohemian–Bavarian–Austrian lynx population

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The Bohemian–Bavarian–Austrian population of Eurasian lynx (*Lynx lynx*) is small, isolated, and threatened by illegal killing and road mortality. The research project „Survival of adult lynx females – research of population threats in the center and at the outskirts of the, BBA lynx population“ aims at assessing the impact of human-induced mortality on population survival. The main goal of the project is to analyse long term data about the survival of adult lynx females in the Šumava National Park, a strictly protected area where most of the human activities, including hunting, are prohibited or restricted, and at the population outskirts, where human-related mortality factors, esp. illegal killing, and road mortality, are more influential than in the NP. Specifically, we will: analyse and quantify differences in the survival of adult lynx females within NP and at the outskirts of the population; assess the probability that the low survival of adult females in the population outskirts is caused by a) health issues, b) road mortality, c) illegal killing; and evaluate the impact of low survival of adult females on the population viability. The project will be implemented in 2022–2024 with the support of TAČR.

Distribution and pathways of introduction of alien plant species in Romania

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Biological invasions are one of the main drivers of modern human-induced species losses. Research on the distribution of alien species and their introduction pathways is essential for understanding and tackling the invasion process. With this study, we aim to contribute to filling this gap and to provide a visualization of national patterns of species invasions, origin and pathways. Patterns of recorded species distribution and pathways of introduction were mapped and visualized using data from an exhaustive database following a major review of the published literature. The present study provides a systematic analysis of invasive and potentially invasive plant species in Romania. The number of occurrences has increased steadily after 1950 s, with new species being continuously introduced. Species originate mainly in North and Central America have been introduced almost equally through intentional and unintentional pathways. Mapping of the species occurrences has revealed several hotspots of recorded alien plant species which concentrate on urban areas. This research is accompanied by a comprehensive open-access spatial database with the collected data. We consider this study a necessary and reliable tool for drafting management and action plans, as well as a good starting point for various analyses as it is further developed and regularly updated.

How to save threatened but extremely specialized subterranean mammals? The experiences of establishing new population of blind mole rats

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Lesser blind mole rats, (Rodentia: Spalacinae) are among the most

threatened mammals of Central Europe. Because of their special lifestyle, the conservation of blind mole rats is especially challenging. Since 2013, a conservation program is underway in Hungary to increase the number of the local blind mole rat populations. Up to date, five new populations have been established near different localities, in order of the year started: Bagamér (2013), Pocsaj (2015), Öttömös (2016) Baja (2017) and Madaras (2020). We collect all the available information about these conservation interventions and use the monitoring data of the established populations in order to evaluate the success of each action and to find an explanation for the significant differences among the results of them. The features of the relocation site turned out to be just as important as the proper implementation of the recommendations of the relevant translocation protocols. Our results may help to make translocation methods more efficient. Since, establishing new populations of blind mole rat in protected areas are not only an important tool for their long-term conservation, but also provide unique opportunity to the examination of the behaviour, annual activity and reproductive biology of these elusive and little known mammals.

Bioclimatic modelling of *Lantana camara* invasion in the Shivalik landscape of Western Himalaya

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Spatial modelling has been an essential tool for predicting and mapping the suitable areas of a species' habitat. Ecological modelling was performed using 744 sampling locations to predict the potential habitat for the invasive plant *Lantana camara* in the lower Shivalik region of the Eastern Himalaya, India. The modelling engaged nine bioclimatic, four topographic, one land-cover, and two soil parameters that are known to be ecologically important for the species. Precipitation of the warmest quarter, mean temperature of the wettest quarter, precipitation of the driest quarter, and river flow accumulation contributed to the model. The predicted area for the invasion was classified into high, medium, and low potential areas. We identified nine potential hot spots based on species occurrence over a 2300 km² area to determine where immediate intervention is necessary to prevent the spread of *Lantana camara*. The study's findings can assist policymakers and stakeholders in developing an effective and strategic weed management approach at the landscape level.

GPS TRACKING REVEALS LARGE AREAS NEEDED FOR COMMON TERNS PROTECTION

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Common terns are often restricted by the availability of suitable sites for breeding. Consequently, conservation effort is usually focussed on management and protection of such islands, sometimes including the waterbody surrounding them. The objective of our study was to assess how far common terns travel from their colonies for feeding during the breeding period. Such knowledge might have important species conservation implications in helping to identify waterbodies that are crucial as foraging grounds for breeding common terns. We used GPS telemetry and successfully tracked 58 common tern individuals from 6 colonies in Lithuania. Despite high variability between individuals, there was high consistency in foraging habits at individual level. Only few birds regularly foraged in close proximity to the colony, while majority regularly endured on longer foraging trips up to 20 km away from the colony. In several cases some birds travelled as far as 50 km and even farther. We conclude that majority of the inland breeding common terns regularly use a variety of waterbodies within 20 km radius around their colonies. Thus, conservation action for the species should consider not only site of the breeding colony, but also possible foraging locations within at least 20 km radius.

The feeding behavior of molting Mute Swan reveals sensitivity to anthropogenic disturbance

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The molting period, when waterbirds change their feathers and cannot fly, can be critical in areas of high anthropogenic disturbance. In the Curonian Lagoon, Baltic Sea, the main shipping line and recreational areas are in proximity with waterbirds' staging sites but knowledge on the feeding behavior of herbivorous waterbirds is scarce. This study integrated satellite telemetry and stable isotope analysis to study habitat use and feeding behavior of molting Mute Swan (*Cygnus olor*). Our data demonstrate that majority of the time molting swans hide in reed beds and feed on reeds which are not the most favorable food in the lagoon. Only during nights, swans reach open water areas and feed in there. This study warns about underestimated waterbird sensitivity in areas where present and developing anthropogenic activities may negatively impact the behavior of waterbirds.

Leveraging big data to decipher public interest in invasive species.

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This study examines the predictive power of search analytics in understanding the public interest in invasive species between 2004–2020. Using Google Insights for Search (GIFS), search popularity for the eight terms related to invasive species was analyzed. Simple linear regression was performed to determine trends. Relative search volume for terms “Invasive species” and “How are invasive species introduced?” steadily increased. Overall, our study highlights the increasing public interest in invasive species. In an era of big data, Intelligence using GIFS can serve as a proxy marker for public biodiversity needs and priorities much before planning for public engagement activities.

Responses of passerine functional Diversity to Environmental variables in Himalayas

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We investigate the environmental correlates of the distribution of the occupancy of functional trait space by Passerines across the Himalayas.

Species arranged in multidimensional functional trait space and multivariate methods volume of the convex hull (functional richness) and principal coordinates analysis (PCoA) were used to investigate and compare the occupancy of this space by 408 Passerine birds.

Auto-regression model, hierarchical partitioning, RLQ and fourth corner analysis were used to identify the most important environmental variable of (i) the macro scale distribution of FD indices, (ii) the range and mean scores for each of the four most essential PCoA dimensions.

Functional richness (FD_{is}) varied between 1.00–1.98 and species richness (SR) ranged from 3.0–284. All environmental variables, temp ($p=0.5856$, $r=-0.035$), humidity ($p=0.985$, $r=-0.001$) Precipitation ($p=0.457$, $r=-0.048$), NDVI ($p=0.460$, $r=-0.048$) were negatively associated with functional dispersion, for all traits. Whereas, SR showed a significant positive association with all environmental variables.

The distribution of functional dispersion of the passerines in the Himalayas is best predicted by environmental variables. Consideration of each of the functional group dimensions individually indicated the importance of both productive and ambient energy, but the role of all environmental variables was minimal for cumulative traits.

Integrating social science and nature conservation: the plurality of researchers' and participants' roles as a challenge and opportunity to promote the biodiversity protection efforts

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Over the last few decades, rapid biodiversity loss has become one of the most contemporary challenging issues. Conservation strategies have shown great benefit in preserving the endangered areas; however, they have also often driven conservation–development conflicts.

In this study, we applied the social–ecological lens to provide critical insight into the plurality of researchers' and participants' roles as a crucial element in promoting biodiversity protection within the social–ecological systems.

Using the Papua New Guinea Tree Kangaroo Conservation Program case study as an example, we demonstrate, how the plurality of researchers' and participants' roles impact the nature protection process. We reflect on our own fieldwork experience, and from social ecology and environmental anthropology perspectives address the key challenges and opportunities, that this plurality creates for the biodiversity conservation agenda. We outline how the construction of space and researchers' position within the system, various stakeholders' interpretation of nature conservation, alongside their diverse expectations, hamper or enable the nature protection efforts. We highlight the importance of addressing and acknowledging the plurality of roles in any nature protection process. Our research findings extend the understanding of the complex social–ecological dynamics and thus provide possible tools for biodiversity protection promotion.

The effect of different forestry treatments on multi-taxon biodiversity in a sessile oak–hornbeam forest: Pilis Forestry System Experiment

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The effect of different forestry treatments on biodiversity was studied in a mature sessile oak–hornbeam forest. The treatments represent the interventions of rotation forestry (clear-cutting, preparation cutting, retention tree group) and continuous cover forestry (gap-cutting). We studied the responses of vascular plant, carabid beetle, spider, enchytraeid worm (Enchytraeidae), crane fly (Tipulidae) and fungi assemblages.

The understory considerably changed in the clear-cutting and gap-cutting, in the gap the community composition kept the forest characteristics, but the clear-cuts were dominated by non-forest weeds and exotic species. For spiders and ground beetles, the species and functional composition changed after the interventions, especially in clear-cutting and retention tree group. Soil-dwelling invertebrates responded the most sensitively to the treatments, they drew back in the clear-cutting and retention tree group. Fungal community composition changed mainly in the clear-cutting and gap cutting. The richness of ectomycorrhizal fungi decreased, while that of plant pathogenic fungi increased with disturbance severity and understory cover.

We can conclude that continuous cover forestry operating with small canopy gaps could maintain the forest characteristics of the studied assemblages, while they are considerably changed in large cutting areas of rotation forestry, which can be compensated only partially by retention tree groups.

Higher temperatures are associated with reduced nestling body condition in a range-restricted mountain bird

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High temperatures can result in reduced parental care and reduced nestling condition in passerines with dependent young, resulting in lowered fledging success and population recruitment. We examined provisioning rate and nestling condition in a mountain endemic, the Cape rockjumper (*Chaetops frenatus*), whose population declines correlate with warming habitat. Our aim was to determine whether reproductive success was affected by high air temperatures. We set up video cameras on nests at three nestling age classes for 8 hours on 37 separate days. Nestlings were weighed at the beginning and end of each film day, barring the four days with mid-day predation. Average mass gain across all nestlings per nest was positively correlated with provisioning rate, and provisioning rate decreased at increasing temperatures. Daily change in mass of individual nestlings was negatively correlated with air temperatures above a significant temperature threshold. This suggests nestling energy requirements were not being met on higher temperature days – perhaps because nestling energy and water demands for thermoregulation are elevated and provisioning rate is not correspondingly maintained or increased. These results suggest that higher temperatures negatively affect nestling mass gain. While in our study this did not directly affect fledging rates, it may affect post-fledging survival.

Distribution models of endangered saproxylic beetle species in pine forests in Latvia. How to evaluate and use them for conservation site selection?

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According to recent estimates, favourable management for biodiversity conservation should reach at least 50% in each ecoregion of world's terrestrial realms by 2050, beginning with 30% by 2030. To rationally reach this target, site selection approach must be based on quantitative ecology and species requirements. Therefore, species distribution models (SDMs) are essential tools for identifying habitats and focusing conservation and management efforts.

To improve site selection in pine forests, endangered beetle species with similar habitat preferences were chosen: *Boros schneideri*, *Chalcophora mariana*, *Nothorhina punctata*, *Tragosoma depsarium*. Previous records were compiled and SDMs for each species and species' group were created. Aim was to evaluate if group model works for site selection with presence of selected beetle species. To reach the aim, 300 optimal, 300 suboptimal, 200 unsuitable and 200 highly unsuitable squares of 1 ha size were surveyed.

We concluded that SDMs for each species work better, but it is possible to use group model to find sites suitable for selected beetle species. There were significant differences between optimal (12%) and unsuitable (3%) squares. Factors as forest age, forest type, distance from sea, forest edge, dominant tree species, amount of pine snags, logs, old pine trees significantly affected species occurrence.

Colonization and control of crows in urban environments: observations on a population explosion

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Corvid birds (crows, magpies) colonizing cities have become a nuisance for urban biodiversity conservation and an understanding of this process is necessary for successful management. We studied Hooded Crows (*Corvus cornix*) in Debrecen (Hungary, E Europe) to document the colonization process and to develop management recommendations. The crow population increased from 11 pairs in 2006 to above 150 in 2019. We observed an increasing use of less-preferred tree species and lower nesting heights, indicating flexibility in nest site selection. Home range size was smaller in winter and summer than in spring and autumn. Survival was lower in winter and late summer than in other seasons in one year but not in another. More crows in the city led to an increasing number of human-wildlife conflicts and the need to reduce crow numbers. In testing four trap types, we found that side-opening Larsen traps and ladder entrance traps were the most effective at catching birds. Based on these experiences, crow control was started in 2019 and led to fewer crows in the city. This study provides information important in our understanding of crow colonization of cities and in developing management strategies to reduce their impact on urban biodiversity.

Establishment of serpentine species after removal of humus layer.

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Hadce u Želivky NNM is one of the most important serpentine sites in the Czech Republic. It is one of the last two areas of endemic species *Minuartia smejkalii*. Despite it is protected, traditional management was abandoned in the area. This led to overgrowing of some parts by competitively strong plants, covering the serpentine soil by humus layer, leading to replacement of the serpentine plants by non-serpentine vegetation.

We implemented intensive management interventions on several parts of NNM Hadce u Želivky during project LIFE for *Minuartia*. The topsoil with humus layer was removed to expose the serpentine bedrock and the development of vegetation was monitored over 5 years. In the first year, the vegetation was sparse and created by vegetatively regenerated plant species (*Poa pratensis*, *P. annua*). In the following two years common grassland species arrived (e.g. *Trifolium species*). Species typical for serpentine habitats such as *Potentilla crantzii*, *Festuca ovina* or *Pinus sylvestris* spread to the sites in the 4th year and serpentine vegetation established in the 5th years.

The results suggest that management interventions leading to recovery of serpentine bedrock are suitable for restoration of serpentine sites. The development of target vegetation is, however, long-term process.

Hotspot and correlates of an occurrence of potentially zoonotic pathogens: a case study of brown bears in Poland and Croatia

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Most emerging zoonoses have mammalian hosts. The recent expansion of large carnivores into highly anthropised landscapes in Europe

increases the potential risk of zoonotic transmissions. Our main goal was to describe patterns of pathogens' emergence with zoonotic potential at local and European scales. First, we collected data from more than 40 studies on pathogens in European large carnivores. Second, we used pathogen data from Polish and Croatian bear populations and assessed the importance of climatic-, species richness-, and human-related factors on the emergence of potentially zoonotic pathogens. In the review, we found at least 80 different species of pathogens belonging to 15 different phyla. *Trichinella* (Nematoda) was the most commonly found pathogen both in the review and local scale. We found that climatic factors were important predictors of pathogens' presence in both populations. Samples located in areas with higher minimum annual rainfall had significantly more pathogens. Human-related factors appeared significantly affecting the presence of pathogens in Carpathian brown bear population, with higher number of pathogens in highly anthropised landscapes. We conclude that climate change and human footprint expansion may boost pathogens' emergence and increase the chances of zoonotic transmissions.

Assessing the differences in habitat structure and avian community of two differently managed forest areas over time

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We assessed the effects of different forest management systems on bird communities, over space and time, in two forested areas within Natura 2000 sites in the Italian subalpine belt that share similar climatic and ecological characteristics. We collected data on the forest structure and the bird community in 2009 and 2019. After computing the variation occurred at the forest and avian community level, considering both the differences in time and between the areas, we assessed the response of birds in relation to the change of the most common forest management parameters. We observed that the non-intensively managed forest was characterised by lower canopy closure, with the presence of large silver fir trees, while the abandoned forest, although it had higher deadwood volume, was shifting to a closer canopy, due to the growth of beech trees. Bird abundances and species richness of most of the ecological and conservation groups reported a consistent increment in time, while some groups showed a significant response to structural variables like canopy closure, trees' density and vegetational conditions. Our results stressed the need for management approaches that enhance the capacity of forests of supporting biodiversity focusing on the availability of key forest features.

Attractive sinks in insect population – plasticity of habitat selection process

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Today we face a worldwide decline in insect biodiversity associated with an unprecedented level of human-mediated environmental destruction and alteration. One of the consequences of these changes is the emergence of attractive sinks. The research is focused on the process of habitat selection in Odonata. The main factor influencing the habitat selection process is the composition of aquatic vegetation. Other proxy cues are the degree of polarized light reflection and the type of the substrate. We tested the susceptibility of Odonata to attractive sinks. The aim was to find out whether the adult chooses a habitat according to its preferences or whether it considers the future performance of the larvae. We found out that dragonflies are able to recognise the real habitat quality. Understanding the mechanism of the habitat selection process in insects is key to preventing the emergence of ecological traps in nature.

Land sparing effect of agricultural intensification depends on who carries out agriculture

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Global biodiversity loss is accelerating, and the main driver of this trend is how we use land. Especially the expansion of agriculture into tropical ecosystems leads to biodiversity losses, through the conversion, fragmentation, and degradation of habitat. Agricultural intensification is seen as a mechanism to avoid that and to 'spare' natural ecosystems. It remains highly unclear though under which conditions such a sparing effect could materialize or whether intensification instead amplifies deforestation through so-called rebound effects. Using a multilevel Bayesian regression framework, we analyzed the effects of intensification on deforestation in the world's threatened but understudied tropical dry forests. We found that the effect of intensification on deforestation heavily depends on social-ecological context. Specifically, we found strong evidence that sparing is likely to happen in lands managed by Indigenous Peoples, whereas a sparing effect is unlikely for areas dominated by agribusinesses. Considering that more than 20% of the world's tropical dry forests are owned or managed by Indigenous Peoples, we suggest that more strongly involving Indigenous and other local communities in land-use planning and conservation, as well as recognizing traditional rights to land, provides major opportunities for sustainable intensification to deliver positive outcomes for people and nature.

Biodiversity as the source of heterospecific social information: the effect on territory selection and vocal mimicry in the Marsh Warbler

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Biodiversity of habitat can indicate food amount, mating opportunities, or strength of the interactions between species, thus, should affect the distribution of individuals that select territories using heterospecific social information.

Vocal mimicry means that males can learn elements of heterospecific songs and include them in their own repertoires. A complex song may be an indicator of male quality and is regarded as attractive to females. The biodiversity of soundscape may describe the availability of song templates from different species. Inhabiting high-biodiversity sites may, therefore, increase individual performance and should increase the population density of mimicking species.

The aim of our study is to understand how the biodiversity of songbirds may shape the distribution, abundance, and song structure of a mimicking bird, the Marsh Warbler. This species inhabits open farmland and its complex song contains a wide range of imitations of different species. We map territories of the Marsh Warbler, record singing males, and count other bird species in Western Poland. In 2021 we conducted the playback experiment broadcasting songs of different bird species within the chosen plots (increased biodiversity of soundscape).

This is the first study experimentally testing the relative effects of biodiversity on species occurrence and behaviour.

Participatory scenarios for restoring European landscapes show a plurality of nature values: from rewilding to cultural landscapes.

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Large-scale ecological restoration is crucial for effective biodiversity conservation and combating climate change. However, perspectives on the goals and values of restoration are highly diverse. We assess how the future of nature is envisioned in participatory scenarios, focusing on which elements of rewilding and nature contributions to people have been considered in scenario narratives across Europe. We used the Nature Future Framework as a template to synthesize pluralistic perspectives of nature. We found that different values of nature are represented as counteracting elements and fail to integrate the plural views of nature. For example, rewilding and conservation of the landscape only appear in archetypes nature for nature, while the improvements on nature contributions to people were found in nature for people archetypes. Our results also highlight two major gaps that should be addressed in participatory restoration planning. Firstly, there is a paucity of spatially explicit approaches. Secondly, we found scenarios that explored co-benefits between multiple nature perspectives were rare. Finally, we introduce the application of novel scenario narratives that explore different nature values needed to envision future scenarios where biodiversity recovery and human well-being are intrinsically linked and fostered.

Edge effects modify effects of fragment connectivity and size on predation patterns of insect sentinel preys and seeds

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Habitat fragmentation threatens terrestrial arthropod biodiversity and it also leads to alterations of ecosystems functioning and stability. Predation and seed predation are important ecological functions because of their community-structuring effects. We addressed the effect of connectivity, fragment size, and edge effect on insect predation (dummy caterpillar) and seed predation by arthropods. We studied 30 forest-steppes and 30 kurgans as grassland fragments. The size of fragments ranged between 0.01 and 6.88 ha. We used 2400 sentinel preys and 4800 seeds in trays for the measurements. We found that increasing connectivity had a negative effect on predation and seed predation rates in the edges but had a minor effect in the centres of kurgans. Fragment size modified edge effects on predation and seed predation rates, in forest-steppes. The difference between edges and centres was more pronounced in small than in large fragments. Edge effects had a strong role in shaping predation and seed predation rates. Our study emphasizes the important role of landscape-, and fragment-scale factors interacting with edge effects in shaping ecosystem functions in natural grassland fragments of modified landscapes. Building functional landscapes to optimize the delivery of ecosystem functions and services in agricultural landscapes needs a multi-spatial scale approach.

Determination of Leucocytozoon prevalence in Central European Boreal Owls

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The Leucocytozoon prevalence in Boreal Owl (*Aegolius funereus*) populations is usually determined by two methods. It is used either quantitative PCR (determines parasite concentration) or nested PCR (determines parasite presence and absence). However, the nested PCR can be highly affected by false positives and false negatives re-

sults. For example, positive samples with a low quantitative Leucocytozoon prevalence could falsely appear negative. One of the relevant approaches to solving the methodological problem of nested PCR is using occupancy models and increasing the repetitions per sample. These models allow approximate occurrence and detect variability of an entire sample frame, considering the probabilities of false negatives and avoiding underestimation. We used this method to determine the prevalence and detection probability of 108 adult Boreal Owls nesting in the Czech Republic. We performed approximately three nested PCR analyses (3.25 ± 0.25) of each blood sample. We used R software with unmarked package and occu function. We found a 74.8% (74.8 ± 4.6) prevalence with the 63.9% (63.9 ± 3.2) detection probability per sample using occupancy models. At the same time, the Leucocytozoon prevalence of our sample population was higher by 25% than the one previously determined in the literature for juveniles.

The flora of Albanian dried-out irrigation ponds and water reservoirs

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Small irrigation ponds and large water reservoirs are a common part of the Albanian landscape. They play an important role in all parts of the country, both for agricultural irrigation and municipal water supply. Due to the severe drought in 2016–2017, these artificial waters largely subsided. On these bare mud surfaces, plants of the class Isoëto-Nanojuncetea, ruderal weeds, nitrophilous species, pioneers, and some species of the surrounding areas appeared. Species appearing at the bottom of reservoirs (as can be said for mud vegetation in general) do not show a high degree of preference for individual site conditions (such as altitude, bedrock, water level). Examining 129 reservoirs, we found 324 species, 35 of which are non-native species. This figure is high given that Albania is the least alien-infected country in Europe. Non-native species are also more common in the lowlands than in the higher altitude regions. We found 5 species that are new for the territory of Albania, 3 of which can be considered as native occurrences.

Singing activity under traffic noise: a case study of Yellowhammer around highways

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The Yellowhammer is a common bird species of agricultural landscapes with a declining population due to agricultural intensification often to be found in habitats near highways. This study found an impact of traffic noise on the singing activity of the Yellowhammer, comparing localities in the agricultural landscape without the impact of traffic noise with localities close to highways. Our results show a statistically significant impact of locality type, pressure, and wind, weakly significant impact of day and cloudiness, and also the interaction of locality and pressure on the singing activity of this species. On localities in the agricultural landscape, we found a statistically significant impact of the distance to the nearest road on the total number of syllables. With increasing distance, the syllabus length and number of syllables were also increasing. The influence of the locality type (i.e. the long-term effect of noise pollution) was found to be impacting the song duration and the number of syllables, and on the contrary, the influence of the day (i.e. the immediate effect of noise pollution) was found to be impacting the onset of singing. Instant and long-term highway traffic intensity also impacted different aspects of the singing activity of yellowhammers.

Effects of land-use change on conservation biological control – A holistic agro-ecosystem perspective

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Preserving natural enemies is essential for the reduction of pest populations, i.e. to preserve the ecosystem service of conservation biological control. Such conservation is however challenging in the context of current land-use change. Land-use changes can affect the diversity of agro-ecosystems including the variety of plant resources and multiple herbivores (i.e., pest and alternative natural enemy prey), on which natural enemies may rely. To understand the effect of land use change on pest control, we model population abundance of pest, natural enemies and an alternative prey in a semi-natural habitat and crop landscape. We simulate land-use change by modifying the diversity of the semi-natural habitat's plants (e.g., loss of plant diversity). Modifications resulted in less herbivore resource consumption in the semi-natural habitat, with subsequent negative effects on natural enemy populations and biological control in the crop field. We also provide a detailed mechanistic and causal link between land-use changes and biological control in an agro-ecosystem context. Our study provides important knowledge on land-use management in agricultural landscapes aimed at promoting conservation biological control.

Birds' response to different types of conservation management on semi-natural upland grasslands

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The study compares number of species and abundance of birds under three different types of conservation management: i) two cuttings (TC), ii) one late cutting (for Corncrake support; OLC), and iii) extensive cattle grazing (ECG). All treatments are among the agri-environmental schemes used for grassland management in protected areas. Bird surveys were carried out during the 2020 breeding season by a point census method (60 points, 20 for each treatment) within the Krkonoše Mountains National Park in the Czech Republic. OLC and ECG treatments were associated with higher numbers of grassland-breeding species compared to TC. The lowest number of species not breeding in grasslands occurred under OLC. Abundance of species breeding in grasslands did not differ among the schemes. Nevertheless, abundance of species not breeding in grasslands did differ between OLC (lowest abundance) and ECG (highest abundance). Moreover, altitude was found significantly to influence number of species as well as abundance of all bird species.

The main conclusion emphasizes the importance of a diverse mosaic consisting of different types of grasslands and different conservation management. The OLC scheme was shown to have greater effectiveness for species breeding in semi-natural upland grasslands and ECG for those species which do not.

Green Security games under incomplete information: A simple game-theoretic model for anti-poaching strategies

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The Green Security Games framework model interactions between « attackers » and « defenders » in conservation domains. Rangers cover a set of sites with different conservation values against poachers who may attack them. The number of sites exceeds that of rangers and poachers. GSG allow to compute rangers' (randomized) allocation strategies to protect as much biodiversity as possible. Repeated interactions are assumed between rangers and poachers, whose behavior is modeled through a parameterized strategy which adapts to the rangers' strategy. A Stackelberg equilibrium, defining an « optimal » rangers' allocation strategy, is computed. GSG assume

a complex model of bounded rationality of poachers, « knowing » (through learning) rangers' strategy. It also assumes full communication between rangers on the field, which is unrealistic, given the risk of communication interception.

Instead, we suggest a new, simple, game-theoretic interaction model between rangers and poachers who we assume only perfectly know the amount of resource in sites. We model « optimal » strategies of poachers and rangers as Nash equilibria of a normal form (polymatrix) game, which can be computed easily. Finally, we show how to relax the perfect knowledge assumption, while keeping Nash equilibrium computable for problems of realistic size.

Benefits of reduced management practices on soil microbial functional diversity in vineyard agroecosystems

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Vineyard are among the most intensive managed agroecosystems with a high impact on biodiversity. Soil microbial diversity can be negatively affected by conventional practices while more ecologically practices are claimed and needed. The aim of this study was to assess the influence of conventional vineyard practices (CONV) and more ecologically intensive practices (ECO) on soil functional microbial diversity measured as community level physiological profile (CLPP). Thirteen vineyards from Podisul Tarnavelor (Romania) having both kind of practices (CONV and ECO) were selected for analyzing. Soil was sampled in 2020 and analyzed for its biological parameters. CLPP was performed with MicroResp multi-SIR method (Campbell et al., 2003) which use 15 different carbon substrates to incubate with wet soil at 25 °C for 6 hours. Substrate utilization pattern given by the amount of CO₂-C (μgC·g⁻¹·h⁻¹) metabolized from each organic substrate was used to compare treatments. The results showed higher average respiration rate for CONV treatments compared with ECO treatments. Carboxylic acids showed the highest respiration rates while the smallest was observed for amino acids substrate. No significant differences were observed between treatments when we look at the general pattern of substrates utilization, but some specific substrate showed significant different values between treatments.

Structure, History and Natural values in a pine-dominated forest nature reserve close to the city of Sundsvall, Sweden

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What are the natural values in forests situated close to cities? This question was addressed in a project 2020–2021, a collaboration between the local municipality in Sundsvall and Mid Sweden University. Forests close to cities often has a high recreational value. A 140 ha nature reserve, mostly coniferous forest, very close to the city of Sundsvall has more than 100 000 visitors per year, including study visits from schools with educational purposes. However, the question is whether it is possible to combine the use from the public with preserving the forest and its natural values. There are some challenges regarding, for example, conveying the message of the importance of dead wood. From the public, logs and snags are often perceived as “garbage” that gives an impression of an unhealthy forest. The forest structure and natural values were investigated during 2020 and it was found that the pine-dominated forest have rather high natural values with trees older than 300 years present. However, the amount of dead wood was much lower compared with more natural forests. There are several outcomes of the project, the main being providing a basis for revising the management plan and various information initiatives for the public.

Exposure to urban metals alters bumblebee behavior

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Post-industrial cities have become focuses of pollinator urban greening initiatives due to their large holdings of vacant lands, however, also have a history of soil metal contamination. Urban bees are exposed to metal concentrations while foraging that cause elevated brood mortality. Sublethal exposure to certain metal pollutants challenge honey bee memory and foraging efficiency but the impact of sublethal metal exposure on bumblebee foraging is largely unknown. We examined how field realistic concentrations of chromium influence bumblebee behavior using RFID tracking systems. We predicted that bumblebees orally exposed to chromium will perform fewer and shorter foraging bouts compared to uncontaminated bees due to challenged memory. Eighty test bees from four naïve *Bombus impatiens* colonies were tagged with unique RFID tags, randomly assigned to treatment (0.46 µg/L Cr2O3) or control (uncontaminated sucrose solution), and deployed to forage for 14 days. Cr concentrations were based on field-realistic concentrations found within bumblebee collected provisions. Paired RFID readers measured directionality, foraging duration, and return colony ID for RFID tagged bumblebees. Chromium fed bees performed fewer and shorter foraging bouts and were more likely to enter a non-natal colony. Our findings illustrate that sublethal chromium consumption effects bee forage frequency, duration, and return navigation.

A national-scale assessment of the main non-native tree species invading forest categories in Italy

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In Europe, many non-native tree species have been introduced and, in some cases, have spread outside the planting areas causing impacts on biological and landscape diversity. Recent studies have focused on the distribution of invasive non-native trees in different natural and semi-natural habitats. However, there is a lack of studies considering their distribution among forest categories, units of classification of forest stands useful for their management. In this work, the forest categories currently or potentially undergoing invasion by invasive non-native tree species were identified for Italy. Based on published works, dedicated databases, and a standard evaluation method, the level of invasion by each non-native tree was assigned to each forest category. The most invaded forest categories were riparian, chestnut, and oak-hornbeam woodlands as well as the Mediterranean maquis. The forest categories most at risk of future invasion by non-native trees were oak, beech and pioneer forests. Tree of heaven and black locust invaded the greatest number of forest categories. Whereas, cherry laurel had the highest number of potentially invadable categories, representing an important future threat to Italian forests. Our results can provide support to forest management aimed at preventing invasions or mitigating their negative impacts on forest ecosystems.

Do we have enough data to assess large-scale trait diversity?

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Studying large-scale trait diversity can provide insights into the impact of human activity on ecosystem function and aid in conservation prioritisation. However, the trait datasets that can aid these studies are often biased or incomplete, and confusion remains about the impact this has on how we measure and compare trait diversity. To address this knowledge gap, we used a near complete bird trait

dataset simulating random and biased removal of data to assess whether trait diversity metrics are resilient to data incompleteness, and whether data imputation can overcome missingness and bias in empirical data. Specifically, we compared three methods commonly used to define trait space (with their associated metrics of trait diversity): distance-based methods (rao), convex hull (richness) and probabilistic hypervolumes (richness, evenness and dispersion). We found that trait diversity metrics were resilient to moderate missingness and bias without imputation, and severe missingness and bias with imputation. Probabilistic hypervolumes were particularly resilient to missingness and bias when combined with imputation. While dedicated efforts to capture intraspecific variation and increase the number of traits represented should continue, our results suggest that available methods and data can successfully quantify large-scale trait diversity.

Citizen science for nature conservation in Hungary, an overview experiences three dimensions

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Our research aim is to assess nature conservation related citizen science (CS) projects in Hungary based on the analysis of documents and interviews carried out among CS project managers. First the main characteristics of the projects are described and compared. It is followed by the analysis of projects related to three dimensions of CS: 1. securing the scientific sound output of the projects by validation, 2. the use of project outputs in nature conservation, 3. environmental education of participating citizen scientists. Our results show that the duration of the assessed CS projects vary from decades to few years, they target protected and/or invasive species and projects are run by NGOs, state organizations and research institutes. There is a variation in the methods of monitoring from only registering the GPS coordinates to using an international monitoring protocol. Apps and more traditional methods are used for registering data, and results are shared through internet based platforms. Validation vary and might include even site visits. Outputs supplement scientific monitoring systems, are used for planning payment schemes and management of the species. Knowledge transfer to participants is usually done through internet based platforms. Possibilities for discussion might be used as well to enhance learning.

Habitats and climate change in Slovakia

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Over the centuries, Slovak landscape and its habitats have been changed by human activities and as a result today's Slovakia is covered with a mosaic of natural and semi-natural habitats surrounding urban and other intensively used land. Habitats depend on natural conditions, especially relief, specific soil, hydrological and microclimatic conditions. The aim of our study was define the most threatened habitats by climate change. We focused on the current conservation status of habitats of community interest (defined in Habitats Directive), distribution, conservation measures and pressures and threats. The assessment was performed based on the results of monitoring data of habitat of Community Interest in the period of 2013–2018, focusing on threats/pressures related to climate change. The selection of threatened habitats was also supported also by literature review on climate change-dependent habitats and a sociological survey focusing on the perception of climate change and habitats by experts in the field of biodiversity and ecology. Climate change is altering key habitat elements that are critical to wildlife's survival and putting natural resources in jeopardy. The most threatened habitats by climate change are wetlands, however many other habitats are significantly affected as well. This work was supported by ITMS2014+ 313011W580 – URANOS.

Private protected areas – a recognized solution for conservation, an unrecognized legal figure in Venezuela

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Ecologically representative network of protected areas is the cornerstone of an effective global biodiversity conservation strategy. We investigated how much 20 private (and community) protected areas (PPA) in Venezuela contribute to the conservation of wildlife and guarantee the provision of ecosystem services. PPA in Venezuela, one of ten most biodiverse country in the world, are not explicitly legally recognized.

We estimated forest cover protected by PPA and fauna and flora richness, identifying vulnerable species using camera traps, nets, traps and botanical collection. We used survey to investigate the perception of PPA in Venezuela focusing on limitation in their creation.

We found that over 8000 ha of forest is protected that constitute > 50% of all investigated PPAs area. Vulnerable species such as American tapir or American puma were registered and approximately 250 species of vascular plant for different PPA. With > 100 interviewees we found that half have a perception of legal existence of PPA in the country and as the most important limitations considered are lack of: financing and official legislation and policies. Creation and adequate management of PPA is a great opportunity to actively protect species, mitigate climate change and involve local communities in conservation.

Monitoring bat populations in savanna biome: a case study in Kruger NP.

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Savanna biome represents an essential component of global biodiversity, it occupies a fifth of the earth's land surface and hosts among other rich bat communities. Yet, whether these communities represent mere ad hoc assemblages of incidentally co-occurring forms or distinct entities strongly adapted to specificities of savanna biome is still not clear. The results of two-year acoustic monitoring of bat communities under a highly standardised design of multidisciplinary project MOSAIK (Monitoring Savanna Biodiversity in Kruger NP) enabled us to analyze bat communities (in total 130,888 individual bat records, 31 acoustic parataxa) in regards to a large set of contextual predictors, seasonal effects and differences at point, local and regional scales.

Besides references to proximal factors (rivers, campsites, microgeographic cohesivity etc.) the results revealed: (i) extensive between-season differences (inverse contributions of molossid and vespertilionid bats), (ii) unexpected homogeneity in community structure at local and regional scales, (iii) common habitat preferences in all taxa approaching the centroid of regional habitat variation, and (iv) greatly pronounced community nestedness. In these regards, the studied bat community represents a unique entity integrated with network of co-existence relations arisen during course of long savanna history. Indirectly, it strongly support an enormous conservation value of savanna biome.

Effects of Carbamazepine on zebrafish (*Danio rerio*) body shape: a chronic experiment with environmental concentrations

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Over the past decades, there has been growing concern about the increasing number and quantity of Pharmaceutically Active Compounds (PhACs) measured in natural waters. Although their observed concentrations are characteristically far below therapeutic doses, their semi-persistent presence, their potential for bioaccumulation, may cause serious damage to aquatic organisms. In a Europe-wide survey, the Carbamazepine (CBZ) was one of the most frequently detected compounds (occurred in 95% of the samples) at the highest concentration of 11.6 µg/l. In this long-term (4 months) experiment 5 groups (control, 5 µg/l, 25 µg/l, 50 µg/l, 75 µg/l, respectively) of zebrafish (*Danio rerio*) were held in CBZ solutions. Digital images were taken from 30 individuals/group monthly and their body shape was analyzed using landmark-based Geometric Morphometrics method. Results indicated the well observable effect of CBZ even on environmental concentrations. Although there is no clear concentration-related trend in body shape change, however considerable similarity was observable between the control and lowest concentration groups, as well as the higher concentration groups had much more different shapes. Although fish are not considered to be particularly sensitive to Carbamazepine, our results suggests that there are observable sub-lethal effects either at environmental concentrations.

Unequal participation of European countries in IPBES

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IPBES is a platform to strengthen the conservation of biodiversity and ecosystem services for human well-being. It is declared to be geographically representative. After our global analysis (Báldi & Palotás, *Conserv Letters* 2021), now we scrutinise how countries of the European continent are involved in IPBES and their share in the authorship of IPBES-related scientific papers. We evaluated the authors' countries of the Europe and Central Asia regional assessment (ECA) for the former and of the Web of Science literature database (WoS) for the latter. Our results show that from the four subregions in ECA (Western-, Central-, Eastern-Europe (including whole Russia) and Central Asia; WE, CE, EE, and CA, respectively), two-thirds of contributors affiliated in WE, 12% in CE, 16% in EE, and 4% in CA. At the country level, affiliations belonged to 42 countries, with the first ten countries providing 62% of all authors. Nine belong to WE, though Russia gave the most experts (25). Regarding WoS articles, we identified 759 authors from ECA countries, of which 95% were from WE. Although the effort of IPBES to involve non-WE authors is apparent, much more work is needed to build up the capacities across Europe and Central Asia.

Impacts of El Niño drought on logged Bornean rainforest

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Carbon and diversity losses from deforestation and selective logging may be partially offset by the recovery of the secondary forests in the tropics. The recovery of forests from selectively logging is of importance for biodiversity conservation, especially in Southeast Asia, where the relative deforestation rate is the highest among any major tropical regions and selective logging is a widespread harvest technique. In Borneo, despite the key role of logged forests in the human-altered landscape, information on the secondary forest recovery remains scarce.

Since 2011, we have been monitoring annual tree growth, mortality, and composition recovery along logging gradient in tropical rainforest in Malaysian Borneo. The results show that increasing the intensity of logging increased the magnitude of the compositional changes, raised the proportion of pioneer species, and decreased the percentage of late-successional species (dipterocarps). During 2011–2020, the pioneers grew initially faster than dipterocarps, thus causing faster regrowth of heavily logged plots, however, their growth rate dropped significantly during the El Niño drought (2015–2016) and was similar or lower than that of dipterocarps since then (i.e., did not recover). The findings indicate that the logging-induced compositional changes make the forest more vulnerable to future drought events under climate change.

Bushmeat hunting in the cross-border area of the Republic of the Congo with a particular focus on pangolins (*Pholidota*): ongoing study

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The Congo Basin is known for its high levels of biodiversity and remoteness, where communities still often depend on natural resources and bushmeat consumption. In recent years, road development and logging activities have increased, and a transnational highway Ouesso-Bangui-Ndjamena is currently under development in the north of the Republic of the Congo. This could cause a higher exploitation rate for the local biodiversity and disturb the integrity of the forest. Pangolins (*Pholidota*) belong among the most favourite species for bushmeat consumption in sub-Saharan Africa and are also highly valued for illegal international trade, mainly used in Traditional Chinese Medicine. Three species of pangolins live in the RoC, all protected by national and international law. Our research is placed in the cross-border area of two countries: the Republic of the Congo and the Central African Republic. We focused on this region using pangolins as an example to evaluate the multidimensional situation threatening the local wildlife. We conducted the first 360 semi-structured questionnaires with various stakeholders between December 2021 and February 2022 in northern Congo. We want to present some of our preliminary results since, in the upcoming months, the data collection will continue in both countries.

Effects of 12 invasive plant species on pollinators in Central-Eastern Europe

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Invasive plants alter the availability of floral resources, affecting pollinators in negative, positive, or neutral ways. We studied the impact of 12 invasive plant species (*Ambrosia artemisiifolia*, *Asclepias syriaca*, *Erigeron annuus*, *Erigeron canadensis*, *Gaillardia aristata*, *Helianthus tuberosus*, *Impatiens glandulifera*, *Reynoutria japonica*, *Rudbeckia laciniata*, *Solidago canadensis*, *Solidago gigantea*, *Symphotrichum lanceola-*

tum agg.) on floral resources, wild bees, honey bees, and hoverflies. We sampled invaded and control site pairs in Hungary and Romania, once before and once during the flowering of invasive species. Flower abundances, wild bee, hoverfly abundances, and species richness tended to be higher in control sites before, and in invaded sites during the flowering of the focal invasive species. The abundance of honey bees was higher in invaded sites during the flowering of invasive species. However, invasive plants had species-specific effects on plant-pollinator systems. The high difference in effects before and during the flowering of invasive plants highlights the importance of repeated samplings over the vegetation season. Although plant invasion is one of the main threats in the conservation and agriculture, invasive plants could be resources for some pollinator taxa. Therefore appropriate eradication methods should also consider pollinators using the invaded habitats.

Flower strips and organic farming maintains high overall functional diversity of pollination related plant traits

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Agri-environment schemes (AES) are among the most valuable instruments to support pollination in agricultural landscapes. In our two-year assessment, we studied the effectiveness of two popular AES management types (organic farming vs flower strips) on plant traits associated with pollinator attraction and reward accessibility. We sampled the vegetation in organic and conventional winter wheat fields with and without flower strips (control) in ten landscapes along a mean arable field size gradient in Central Germany. We calculated the community-weighted mean and functional diversity of traits and tested the effect of field size, management, and within-field position (grassy margin, field edge, flower strip, field interior) with linear mixed-effects models. Landscape configuration expressed as mean field size did not affect pollination traits in our study. Flower strips provided an exceptionally high cover of insect-pollinated plants, but their establishment in field interiors was not detectable. In contrast, organic field interiors could be considered a favourable place for pollinators compared to the interior of conventional fields.

As both organic farming and flower strips maintained abundant and functionally diverse insect-pollinated flora, a combination of both might be the best option for sustaining pollinators and their services.

Investigating possible impacts of wild boar (*Sus scrofa*) in the urban habitat of the strictly protected Caspian whipsnake (*Dolichophis caspius*)

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Ungulate activities can have significant top-down effects on the structure of plant communities resulting in indirect impacts on the habitat of other animal species. Our research is looking at wild boar (*Sus scrofa*) impacts in an urban habitat of strictly protected Caspian whipsnake (*Dolichophis caspius*). We surveyed an area of 3.2 ha in Vöröskővár in Budapest, where shrub encroachment is a threatening factor. To investigate the impacts of wild boar rooting in the area, we designated adjacent rows of 20x20m grid cells parallel to each other (n=81). We used GPS data to measure the lengths of rooted patches monthly, and estimated the percentage of area covered by rooted surface and availability of woody vegetation in each cell. Parallely, we evaluated the possible impacts of wild boar rooting activity on sapling density and shrub cover. We found that on average 41% of cells were rooted. More rooting was found in cells with more shrubs than less shrubby cells. There were less saplings in cells with more rooting and more saplings in cells with less rooting. It is important for management to monitor and, if necessary, control wild boar densities and their impact on the vegetation even in such special urban habitats.

Assessing of coastal habitat quality in relation to conservation objectives on the southeast Baltic Sea coast in Latvia

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Assessment of habitat quality carried out based on the mapping of EU protected habitats in Latvia (2017–2021). Along entire 495 km long Latvian coast in total 65 427 ha of halophytic and dune habitats were mapped. Information on habitat structures, ecological processes, impacts, and species were entered on the standardised data forms and collected in the Nature data management system „Ozols”.

Data on 18 164 habitat polygons have been analysed in order identify the most important parameters used to improve algorithms for the assessment of habitat quality and defining conservation objectives. Algorithms were developed for each of 12 coastal habitat type within LIFE-IP “Optimising the Governance and Management of the Natura 2000 Protected Areas Network in Latvia” (LIFE19IPE/LV/000010).

The most important quality indicators are related to coastal geomorphology and anthropogenic factors. In case of grey dunes significant is bare sand patches, lichens, cover of litter, trees and shrubs. The most important indicators of the quality of wooded dunes are the presence of old trees and dead wood. In all cases, the presence of invasive and expansive species can significantly affect quality. These parameters correlate with the occurrence of characteristic, rare and protected species.

Effects of an invasive grass, the sand dropseed (*Sporobolus cryptandrus*) on arthropod assemblages in sand habitats of Hungary

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The unique fauna and flora of sand habitats in the Pannonian ecoregion are strongly affected by non-native plants. Recently, a new American grass species, the sand dropseed (*Sporobolus cryptandrus*), have appeared and spread in the sandy habitats of Danube-Tisza Interfluve. We aimed to assess the effect of sand dropseed on the arthropod assemblages in sandy habitats. We sampled arthropods in three habitat types (forest-steppe, open sand grassland, and degraded sand grassland). In each habitat type, we selected five pairs of sites (invaded and non-invaded sites) and sampled the ground-dwelling and plant-dwelling arthropods by pitfall trapping and sweep-netting, respectively. We examined the activity- density and/or abundance of various arthropod groups by generalized linear models, with habitat type (forest-steppe, open sand grassland, and degraded sand grassland), dropseed invasion (invaded vs. non-invaded) and their interaction as explanatory variables. We found that the majority of arthropod groups were significantly affected by habitat type. However, the invasion of sand dropseed affected mostly the plant-dwelling arthropods (orthopterans, hemipterans flower-visiting insects) and ants, in contrast to ground-dwelling arthropods such as ground beetles and ground-dwelling spiders. In addition, the significant interacting effects suggested that arthropods were affected by dropseed invasion differently in the different habitat types.

Forest management effects on aerial fungal biodiversity

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Boreal forests host a high diversity of fungi, including endangered and critical red-listed species. Large-scale clear-cutting and planting have during the last century radically changed forests structure and composition.

In this project, we investigate how clear-cutting has affected air-borne fungal biodiversity in Norwegian boreal forests. We expect to

find a more diverse fungal community, including rare and red-listed species, in near natural forests compared to earlier clear-cut forests. This will be tested by comparing the fungal diversity in nine replicated pairs of forest plots, each pair constituting one mature near-natural forest not clear-cut and one mature forest that has been clear-cut once and then planted or regenerated. Passive spore traps with filters were used to monitor the air-born fungal diversity in the plot during the period September–November 2021. The results from the DNA-metabarcoding analyses will be presented.

Our results will inform how intensive forestry practices affects the biodiversity and composition of fungi, which can give clues sustainable forest management practices. The spore sampling approach we are testing in this project has the potential of supplementing traditional fruit body surveys to better understand monitor fungal biodiversity.

Genetic tools to inform marine protected areas establishment: a case study of an isolated fish population in the Southwestern Atlantic

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Despite the lack of obvious barriers, populations of marine organisms can present different levels of connectivity throughout their distribution. The degree of connectivity between populations of exploited species should be considered when defining conservation measures. Here we investigated the genetic connectivity of the endemic and exploited Gray Parrotfish, *Sparisoma axillare*, in Brazil. Due to its vulnerable status, much ecological data is still needed to support sustainable management actions and protected areas implementation. Nine locations were sampled from reef systems in coastal to oceanic environments with varying levels of protection. The combination of depth, ocean currents, and distance were the major drivers explaining patterns of genetic divergence between *S. axillare* populations. Coastal populations and two off-coast sites showed high connectivity. A distinct genetic population was revealed in the waters surrounding Trindade island, located 1000 km off-coast. A large no-take area has recently been established in part of Trindade, increasing the country's marine protection. However, this loosely regulated area is located in the open ocean, excluding shallow areas. Despite bans to fisheries, these areas are still exploited. Granting Trindade full protection would provide a response to criticisms and give some respite to a unique *S. axillare* lineage.

Habitat on the move – Translocation of deadwood and associated species as a mean to improve ecological compensation

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The study objective was to test a novel method in ecological restoration/compensation, translocation of high quality deadwood and its associated species. This method could potentially solve the ‘Field-of-dreams dilemma’ in ecological restoration, i.e. even if proper efforts and actions to create suitable habitats are conducted in an area, there is no assurance that species or functions will self-assemble. We tested this method as a way to compensate for biodiversity loss due to the expansion of the Aitik mine. Deadwood (including associated saproxylic species), both standing and lying, fresh and belonging to multiple decomposition classes, in total 640 substrates, was translocated from the impact area to a compensation area into 30 experimental plots, receiving 0, 16 or 48 deadwood substrates. Baseline

measures of insects, bryophytes and wood fungi in both impact and compensation areas were conducted prior to the translocation. Our result showed that translocation increased deadwood volumes in the compensation plots to levels equal or above those found in the impact area, but also the lack of some types of deadwood. Saproxyllic beetle density and diversity, especially of rare and red-listed species, increased in the compensation plots, thus indicating the potential of this novel method to mitigate biodiversity loss.

Protist infections in mountain gorillas (*Gorilla beringei beringei*) across Virunga Massif

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Ongoing conservation success of endangered mountain gorillas (*Gorilla beringei beringei*) coincides with increasing population densities, which may alter parasite epidemiology. Recently, striking geographic differences in helminth infections were revealed in Virunga gorillas, with higher egg counts and specific strongylid taxa occurring in high-elevation areas with high occurrence of clinical gastrointestinal symptoms. However, our knowledge about protist diversity and epidemiology in mountain gorilla populations are still limited. The goal of the study was to assess patterns of *Cryptosporidium*, *Giardia* and microsporidia infections (intestinal protists spread by the fecal-oral route via environmentally resistant cysts) in mountain gorilla across the Virunga Massif. We examined 152 fecal samples from 16 gorilla groups collected in 2018 using molecular diagnostics (PCR and qPCR on various markers). We detected *Enterocytozoon bienewisi* (14%, genotypes D, NCF7, CHN-F1, gorilla 6), *Cryptosporidium muris* (1%) and *Giardia intestinalis* (9%). In comparison to results from 2007 we did not detect *Encephalitozoon cuniculi*. We showed that the most sensitive methods for pathogen detection must be employed and a long-term monitoring of selected pathogens is warranted. Our results further aid epidemiological understanding of parasite communities in mountain gorillas, an asset for their ongoing conservation management in the face of newly emerging health challenges.

Plant biomass and insect assemblages on overseeded old fields in Central Hungary

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Abandoned arable fields (old fields) could be improved by overseeding to promote feed (biomass) and insect diversity. We started our experiment in arable fields abandoned about ten years ago in Central Hungary. We overseeded nine parcels (each 0.5 ha) with a seed mixture of 11 native, legume-rich species and designated control parcels. We sampled plant biomass by harvesting 50×50 cm plots (6 per parcel) and captured flying insects with Malaise traps (1 per parcel). We identified bee, butterfly and wasp species at the species level. We analysed biomass with GLMMs and the diversity of insect assemblages with GLMMs and NMDS. We found a significant positive effect on biomass. Nor abundance, neither species richness showed difference between overseeded and control parcels. Furthermore, the NMDS analysis did not show any effect of overseeding on species composition. Thus, our preliminary analyses suggest that while plant biomass increases after overseeding; bee, butterfly and wasp assemblages did not differ between control and overseeded sites in the first two years after treatment. We suspect that the slow development of flowers due to a lack of precipitation and a delayed response of insects to the treatment might contribute to the observed lack of short-term effects on insects.

Non-linear benefits of small woody features on agricultural biodiversity to a larger extent in cropland than in grassland

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Farmland communities have declined since several years due to multiple factors (e.g pesticides, landscape fragmentation). At the European level, different agricultural policies seek to support farmland biodiversity, among which devoting part of farmland to non-productive areas of ecological interest, promoting small woody features (SWF) such as hedges. However, the effect of these landscape features is complex as it could be taxon-specific, landscape-dependent and non-linear. A better understanding of these effects is therefore crucial to provide supporting elements for policy decision making, as in the context of Common Agricultural Policy (CAP) reform. We propose a large-scale multi-taxon study to explore the impact of SWF on farmland biodiversity in France (3730 birds, 492 bats and 670 orthoptera community plots). Using generalized additive mixed models (GAMMs), we show that these three taxa share a nonlinear relationship with these SWFs on the structure and diversity of their farmland communities. We illustrate that this effect is highly pronounced in croplands but not in grasslands. We recommend that future conservation policies should achieve a minimum of 3% SWF landscape cover as a priority in cropland. We illustrate, however, that some agricultural species are unlikely to benefit from these landscape features and thus require other protection measures.

Establishing boundaries in Conservation Biology: The case of European wild rabbit subspecies in the Iberian Peninsula

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Conservation action is premised on the establishment of boundaries, such as the species concept that delineates, through various definitions, the boundaries between different species as categories of conservation relevance. These definitions are socially constructed and thus influenced by ideas, interests and institutions. Therefore, understanding how actors involved in the management of a certain species establish its boundaries can be decisive to set up adequate future frameworks of action. This becomes even more relevant for species facing conservation challenges, such as the European rabbit (*Oryctolagus cuniculus*). Here, we explore how the main interest groups involved in rabbit management in its native range perceive wild rabbit subspecies. To this end, we conducted a discourse analysis of more than 40 interviews with representatives of each group across the Iberian Peninsula. Results showed how all interviewees were aware of the existence of subspecies and most of them recognized differences between them. However, results also revealed a clear division between the discourses in each subspecies' area and between different actor groups, which reflected different relevance of the subspecies in management. These results may be valuable for the management of rabbit subspecies, but also highlight more general social mechanisms behind the construction of the species concept.

Plant tissue culture as strategy for conservation and toxicity study of the endemic and endangered Bamboo Cycad (*Ceratozamia hildae*): applications and challenges.

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Biotechnology of Plant Tissue Culture has been proposed as a strategy to solve the conservation problem that threatens the most vulnerable plant group worldwide, cycads. But all cycads are considered to be neurotoxic. In this project, we evaluated the protocol for the Bamboo Cycad *Ceratozamia hildae* implemented for the first time in 1992 and currently successful through physiological, morphological, phytochemical and anatomical aspects.

Morphogenetic responses are described such as somatic embryogenesis, organogenesis and undifferentiated cells identified as callus (from which, morphologically unknown structures were observed and after additional anatomical procedures, they were identified as idioblast cells). Methanolic extracts of culture medium present metabolites of interest.

In this way, we corroborate that plant tissue culture is not only a strategy for in vitro conservation but also with a potential impact in a sustainable economy such as promoting the search for regeneration of complete individuals and obtaining metabolites of interest under controlled conditions.

In this sense, new studies would be opened to evaluate the feasibility of reintroduction or, failing that, the regulated use of plants without looting wildlife.

Multi-taxa modeling approach to evaluate the importance of non-crop habitat proximity in ecosystem services distribution: a case study in the Czech Republic

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Non-crop habitats such as field boundaries offer shelter and food sources to various beneficial organisms, from which they can spread and colonise crops during favourable seasons. Most studies use a single taxa approach to evaluate the distribution of beneficial arthropods. Here we adopted a multi-taxa approach and direct measurement of ecosystem services (ESs) to assess the relationship between distance to field edges, agro-communities, and ESs.

Eight arthropod taxa and three ESs were investigated using vegetation sweeping, pitfall and pan traps, dummy caterpillars, seed cards, and teabag technique. Generalized linear mixed-effects models (GLMMs) synthesize the response of arthropods abundance, diversity, and ecosystem services to the distance from field boundaries. Preliminary results showed that ecosystem services increased locally together with arthropod diversity and abundance. No effect of distance from field boundaries on the surveyed arthropods and ecosystem services was observed, while only a few habitat specialists were confined near field boundaries.

This study demonstrates the importance of a multi-taxa approach to determine ecosystem service distribution. The modeling approach can be used for deriving a plausible multi-taxa model for evaluating ecosystem services provision.

The red deer viewed by Europeans: A challenge for management

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Red deer (*Cervus elaphus* L.) are distributed throughout Europe, and populations densities have increased over the last years. Lethal control is sometimes used to reduce their numbers, and their negative overabundance impacts on ecosystems. Understanding how society perceive this species, its impacts and its management is important because a potential opposition to control its population, may have negative implications for ecological conservation. To assess such

societal perception on deer and their socioecological context, we surveyed 2,400 people from six European countries: Spain, France, United Kingdom, Italy, Germany, and Sweden. Across Europe, almost everybody knew this species (>99%), mainly because they have seen it in the wild, in books, or on television. Although some differences existed among countries, Europeans generally attributed positive ecosystem services to the red deer, being the most frequently selected ones cultural (by 43%), regulation (35%) and provision (22%) services. Almost 90% of the interviewees liked red deer, 47% would like to see an increase in deer populations, and 49% were worried by the impact of human activities on this species. This study reveals a high appreciation of red deer by European society, and suggests that deer populations control may face social opposition.

Strategy for Rural Development in Colombia: Socio-Economic Analysis of Natural Rubber Plantations

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Natural rubber farming in Colombia is considered the industry with more potential for socio-economic development with a dominant position in the market, more than 50,000 small farmers (51% of them being women) depending on it, hence, there is a great need to nurture and retain this industry because is considered Colombia's best weapons against the war on drugs replacing hundreds of Ha of illicit crops. The Rubber tree *Hevea Brasiliensis* is a native crop that grows in the Amazonian River basin, parts of Caquetá, Putumayo, and Colombia's far east, the Amazon jungle itself. But suffers deforestation and displacement as livestock, pasture production, and illicit crops grow in the area, reducing the possibilities of rubber exploitation, making it urgent from the farmers, and policies from the state to provide means of production, skills, roads, and organizing the Supply chain in order to stop the deforestation on the Amazonas, and helping the population to continue the production of Latex.

More evidence for insect decline in forests? 23 years of ground beetle sampling indicate declines in biomass in a German forest

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An increasing number of studies reports declines in insect populations affecting a variety of taxonomic groups in different habitats. While the full extent of this crisis still remains unclear, the majority of studies focuses on flying insects in open habitats. We investigated if ground-dwelling forest insects are also affected by declines and analysed a long-term dataset consisting of over 23,000 ground beetles caught in a mixed forest stand near Eberswalde, Germany, covering a time span of 23 years. We fitted linear mixed regression models to investigate trends in abundance and biomass. First results highlight that temporal trends in ground beetles are governed by large inter-annual fluctuations. They also show a significant decrease of biomass over time – but not of abundance. This might indicate shifts in species assemblage. At ECCB we plan to present further results from investigations of trends in taxonomic diversity and ecological traits, as well as the influence of climatic conditions on interannual fluctuations. Our research thereby delivers another important “puzzle piece” in the investigation of insect decline and sheds more light on the conservation status of forest insects in central Europe.

Forest management and arthropod functioning in Central Europe: conifers and non-native tree species alter trophic niche structure of predators

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Large scale forest diebacks of Norway spruce in Central Europe have shown the progressing impact of climate change and call for adaptive forest management strategies. Mixtures of broadleaved and coniferous trees or admixing non-native trees to native forests appear promising, but the ecological consequences are poorly understood. Particularly functional diversity of forest-associated biota has to be maintained, constituting an important pillar of resilience and ecosystem functioning. Feeding niches of arthropod predators provide a proxy for functional diversity and therefore, we investigated the trophic niche structure ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$) of dominant spider and carabid communities in mixed and pure stands of European beech, Norway spruce and non-native Douglas fir in Germany. We implemented multidimensional isotopic metrics and found that both conifer species increased feeding niche breadth and functional redundancy of arthropod predators, whilst tree mixtures mitigated such effects. However, non-native Douglas fir harboured shorter food chains than native Norway spruce, and Douglas fir-associated communities reacted stronger to soil type and precipitation than those of native stands. In conclusion, both conifers generally act similarly, but Douglas fir nonetheless shows several distinct and possibly adverse effects on native arthropod communities. Therefore, replacement of native conifers with their non-native counterparts should be implemented with caution.

Climate change driven shifts in the synchrony of apple flowering and pollinating bee flight phenology.

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The phenology, or timing of key life-history events, of many globally important crops and the insects that pollinate them are shifting because of the changing climate. Where these temporal shifts occur at different rates or in different directions, it induces a risk of phenological mismatch, potentially reducing the quality and quantity of crop production, and the fitness of pollinating bees through resource shortages.

This study makes use of 48 years of UK citizen science (pollinating bee flight periods) and systematic (apple flowering) data to report phenological shifts of both apples and their bee-pollinator community. We quantified the mismatches between peak flowering and flight dates which could potentially cause pollination deficits.

Advances in both apple flowering and pollinator flight were primarily driven by early spring temperatures, with peak apple flowering dates of advancing by 6.4 ± 0.6 days per 1°C warming. Early spring temperatures impacted peak flight dates of insects, with an advance of 6.7 ± 1.7 days per 1°C warming.

The different response patterns in the phenology of apples and bees gave rise to shifting temporal mismatch between peak flowering and peak flight, which could have major negative impacts both on apple production, and bee survival.

Spatial-temporal heterogeneity of ecosystem service interactions and their social-ecological drivers across scales: Implications for sustainable spatial planning and management

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Uncovering the complex interactions among ecosystem services (ESs)

and their social-ecological drivers is a prerequisite for developing sustainable ecological management strategies to improve human well-being. We mapped spatial-temporal patterns of six ESs (habitat quality (HQ), water conservation (WC), carbon storage (CS), food production (FP), water supply (WS), and landscape aesthetics (LA)) in the Qiantang River Basin, quantified the trade-offs/synergies of ES pairs, identified ES bundles, and determined the dominant social-ecological drivers of ESs at two spatial scales (grid scale and sub-watershed scale). The results showed that the spatial patterns of ESs were spatially heterogeneous but relatively stable across time, except for two hydrological services (WC and WS). Synergies occurred mainly between HQ, CS, WC, WS, and LA, while trade-offs arose mainly between FP and other ESs. CS-HQ pairs presented the strongest synergy while FP-HQ pairs showed the strongest trade-off at both spatial scales. Spatial-temporal analysis of ES interactions can prioritize ES management not only for ES pairs with trade-offs but also for ES pairs with declined synergies. We proposed spatial planning and management strategies at both spatial scales based on ES bundles and social-ecological drivers to facilitate the sustainable development of regional ecosystems and the enhancement of human well-being.

Long-term disturbance dynamics as a driver of abundance and diversity of tree-related microhabitats in primary forests in Europe

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Improved understanding of the relationship between natural disturbance regimes and habitat availability for biodiversity is critical given that the frequency and severity of forest disturbance is expected to increase due to climate change. Biodiversity indicators such as tree-related microhabitats (TreMs) have recently gained significant attention in research and management, however the relationship between multiple disturbance components and their long term effects has not been well documented yet. Here we used a unique dendroecological disturbance history reconstruction from 297 plots in European primary spruce forests to examine the relative importance of natural disturbances in shaping TreMs occurrence and diversity. The results show that TreM diversity in relationship with long term disturbance dynamics follows a complex pathway with the TreM diversity peak right after a disturbance event. However, disturbance dynamics shaped contemporary TreMs with contrasting effects on different TreM groups. There was found a significant relationship between TreM occurrence and disturbance characteristics in 6 TreM groups whose occurrence peaks differ in disturbance severity and time. The results underscore the importance of considering primary forests as dynamic ecosystems, driven by disturbances where the whole range of seral stages is important for different TreM groups and subsequently forest-dwelling species.

The seasonal variability of ichthyoplankton biodiversity in the central-eastern Adriatic Sea (Jabuka/Pomo Pit area) during the last two years

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Four ichthyoplankton surveys (colder season: October–November, 2020; February – March 2021; warmer season: June – July 2019; 2020) were conducted in the wider area of Jabuka/Pomo Pit. Ichthyoplankton samples were obtained by standard vertical plankton tows using a WP2 sampler (mouth opening, 0.255 m^2 ; mesh size, 0.200 mm) and preserved in 96% ethanol. In the laboratory, ichthyoplankton was isolated under the binocular and its taxonomy was determined using DNA barcoding with cytochrome c oxidase subunit I (COI). Overall, 499 fish eggs and 113 larvae were collected and they belonged to 26 fish taxa. Quantitatively, in the colder season, the dominated taxa was *Maurollicus muelleri* (Gmelin, 1789), while in the warmer season *Engraulis encrasicolus* (L.) early life stages were the most numerous. Biodiversity indices (Species richness (S), Simpson's Index of Diversity (D), Shannon–Wiener Index (H), Evenness (E), Jaccard Index (J)) pointed out that samples obtained within two seasons were quite similar ($J=88.3\%$), although ichthyoplankton samples collected during the

colder part of the year had slightly higher diversity. The application of molecular taxonomy reveals, for the first time, the occurrence of two tuna-like species and Blue jack mackerel early life stages, which might indicate possible spawning aggregation in the study area.

Survival estimation of eastern imperial eagles (*Aquila heliaca*) in Hungary with a genetic-based mark-recapture method

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Intensive conservation work has been taking place to reduce anthropogenic mortality causes, particularly poisoning of the Vulnerable (IUCN) eastern imperial eagle in Hungary. The aim of our study was to estimate survival probabilities of breeding birds for the years 2011–2017 in order to evaluate the success of the HELICON Life project (2011–2016). Probabilities were estimated using a capture-recapture method. The territorial nature of the species made genetic-based individual identification possible through DNA profiling of breeders, from moulted feathers collected at the nest sites. Capture histories were constructed for 144 males and 251 females. Furthermore, genetic monogamy of the species allowed us to gain additional, inferred presence data of breeders through parentage analyses. The three best supported models were (i) constant 90,3% survival over our study period, (ii) sex-dependent survival (males: 88,6%, females: 90,9%) and (iii) time-dependent survival with a 4,2–8,6 percentage point lower survival for the first three years. Slightly lower male survival could be explained by behavioural differences of the sexes: males might face more danger as they spend more time hunting and protecting the territory. Increase in survival through the years is in accordance with the decrease in poisoning rates, which can be attributed to HELICON Life.

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