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Alleviating Effects of Elevated CO2 on Water Utility in Norway Spruce Saplings Under Drier Soil Conditions

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Elevated atmospheric CO2 (eCO2) is expected to affect plant water relations and growth in forests ecosystems globally. Although increased leaf-level photosynthesis under eCO2 is well-documented, less is known about its effects on whole-plant growth and water use in species such as Norway spruce (Picea abies L. (Karst.)). This study explores the effects of eCO2 on the growth, transpiration, and growth-based water use efficiency (WUEBAI) of Norway spruce saplings over two distinct years (2020 and 2021), using semi-open top chambers. Growth dynamics were measured with dendrometers, while sap flow sensors recorded sapling water use, both of which were analyzed alongside microclimatic factors. Additionally, tree water deficit (TWD), an indicator of water stress, was assessed. Linear mixed-effect models were applied to understand the relationships between growth, sap flow, WUEBAI, and environmental factors. We hypothesized that under eCO2, Norway spruce saplings would increase growth and WUEBAI by reducing water use, particularly when soil water content (SWC) was low. Results showed that eCO2 reduced water use more markedly under low SWC. WUEBAI was enhanced under these conditions, but the benefits diminished as soil moisture increased. Although the main effect of eCO2 on WUEBAI was not statistically significant, the interaction between vapor pressure deficit (VPDD) and SWC was significant, suggesting that VPDD influence on WUEBAI weakens as soil moisture rises. This study offers valuable insights into the intricate interactions between eCO2, SWC, and

atmospheric conditions, improving our understanding of Norway spruce physiological responses to environmental changes.

Keywords: Norway spruce, sap flow, dendrometers, water use efficiency

Acknowledgement: The work was supported by the Internal Grant Agency of Mendel University in Brno with grant no. IGA-LDF-22-IP-024. Additionally, the Czech Globe Research Institute provided financial support for conference expenses.

Implementing green-blue infrastructure in Urbans' brownfield spaces to enhance landscape connectivity

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In a gradual urban gradient, landscape interconnectivity from urban areas to fringes is vital for many environmental and human-based activities and services; however, urbanism is creating fragmentation of the urban landscape per se. In this horizontal field of urbanization, the landscape has a newfound relevance, offering a multivalent and manifold medium for the making of urban form, in particular in the context of complex natural environments, post-industrial sites, and public infrastructure (Waldheim, 2006). Green-blue infrastructures (GBI) are the means to stop the excessive growth of grey parcels in addition to the potentials to increase connectivity, mobility, and urban health. Unused lands or brownfields, especially in urban areas and urban fringes, are one of the best potentials to connect sprawled green landscapes in different city zones (Azhar et al., 2016). Theoretical research in the case of urban unused spaces or brownfields started approximately 30 years ago by Trancik (1986), who investigated the aspects and referred to them as 'lost spaces,' as such spaces were ill-defined, had no significant outlook, and had a negative impact on the built environment. Moreover, he argued that such spaces had no definite or measurable boundaries and created division in use through policies or zoning (Azhar et al., 2016; Trancik, 1986). As a result, urban sprawl will cause exponential fragmentation, and due to that, the disconnection of green-blue landscape services is one significant consequence. Thereby, the main approach in this study will be to control this phenomenon and come up with solutions to tackle it. In this study, the aim is to understand how GBI multifunctionality will influence the connection on a large scale, from urban central areas to peri-urban and fragmented parcels.

Keywords: green-blue infrastructure, brownfields, landscape connectivity

Physiological and Biochemical Responses of Norway Spruce to Acute Drought Stress and Their Influence on Susceptibility to *Ips typographus* and *I. duplicatus*

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Norway spruce (*Picea abies L.)* forests in Central Europe are increasingly threatened by bark beetles, particularly *Ips typographus* (L.) and *I. duplicatus* (Sahlberg), with outbreaks often linked to drought-induced stress due to climate change. This study investigates Norway spruce's physiological and metabolic responses to acute drought stress during the growing season and evaluates its susceptibility to *I. typographus* and *I. duplicatus*.

To induce drought, mature spruces were deprived of water through root covering in April 2021, while control trees had normal access to rainwater. Over five months, soil water potential, bark temperature, trunk growth, and sap flow were monitored. Trees were sampled in July, August, and September for non-structural carbohydrates (NSCs) and defensive compounds (phenolics and terpenes). Bioassays with *I. typographus* and *I. duplicatus* were conducted to assess host preference and acceptance.

Drought-stressed trees showed signs of stress by July, with reduced trunk growth and increased NSCs. Defensive metabolites were largely unaffected, except for a rise in diterpenes in September. Bioassays indicated that *I. typographus* preferred boring into drought-stressed trees in August and September, corresponding to elevated soluble carbohydrate levels in the phloem. Both beetle species showed greater mobility on drought-stressed trees in August and September despite consistently higher bark surface temperatures.

In conclusion, Norway spruce exhibited rapid physiological changes to drought, with limited alteration in defense traits. However, drought-stressed trees were more

attractive to *I. typographus*, likely due to the improved nutritional quality of the phloem under acute drought conditions.

Keywords: bark beetles, Norway spruce, drought stress, carbohydrates, terpenes, phenolics

Acknowledgment: We extend our gratitude to the Forest CZU in Kostelec nad Černými Lesy, Czechia, for their valuable assistance and support, and we thank all the students and colleagues who contributed to the fieldwork and sample preparation.

Composite Zeolite Granules for Enhanced Stabilization of Heavy Metals in Contaminated Soils

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The intensification of human activities has resulted in increased concentrations of heavy metals in soils, leading to an increased risk of these contaminants entering food. The chemical stabilization/solidification technique using mineral amendments has emerged as a promising modern approach for soil remediation. This technique reduces the bioavailability of heavy metals (HMs) by converting them to less soluble and/or mobile forms.

Zeolites are widely recognized for their effectiveness in stabilizing heavy metals in soils. However, the reversible nature of the ion exchange process in zeolites can limit their ability to retain contaminants. To improve their stabilization ability, zeolites could be modified by incorporating functional groups on their surface that allow for stronger physicochemical interactions with heavy metal ions.

In this study, the synthesis and application of composite zeolite granules coated with manganese dioxide nanoparticles as an efficient soil amendment for the stabilization of heavy metals/metalloids such as cadmium, lead, zinc, copper, and arsenic are considered. The zeolite granules (clinoptilolite tuff, Sokirnitsya deposit, Ukraine) were synthesized by a controlled coating process. The resulting granules were characterized by various analytical techniques to confirm the successful incorporation of manganese dioxide nanoparticles into the zeolite matrix, as well as the preservation of the structural integrity of the composites.

The effectiveness of composite zeolite granules in the stabilization of HMs in contaminated soil (Přibram, Czech Republic) was evaluated. Composite zeolite granules were shown to significantly reduce the concentrations of Cd, Pb, and Zn in soil, thereby decreasing the mobility and hence the bioavailability of these heavy metals. The

improved stabilization of composite granules compared to zeolite granules could be attributed to the stronger reactive interaction between the manganese dioxide nanoparticles and HMs.

Keywords: heavy metals**,** soil remediation, amendment, nanocomposite zeolite

Acknowledgement: This investigation received funding through the MSCA4Ukraine project, which is funded by the European Union (project N 1233358).

TiO2, ZnO carbon composite for the removal of benzotriazole from water by a combination of sorption and photocatalytic processes

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Organic xenobiotic substances are emitted into the environment from a number of preparations used in industry and households. Some are relatively persistent and difficult to biodegrade, so they pass relatively easily through wastewater treatment plants into the surface waters and contaminate drinking water sources. The goal of this study is to develop an innovative technological material that will be able to eliminate organic xenobiotics in water effectively. The principle of our method is to combine carbon-based sorbent (biochar and hydraffine) with a semiconductor layer (TiO_2, ZnO) to synthesize a photoreactive nanocomposite material which in conjunction with UV/VIS exposure, can efficiently and safely degrade captured organic xenobiotics (benzotriazole, BTR) in water through the processes of sorption and consequent photocatalytic degradation. This nanocomposite should act as more effective alternative to the widely discussed composite biochar-TiO_2. Specifically, the composite coated with ZnO provided the highest degradation efficiency of the photochemical process and it also had the highest sorption capacity for BTR because of the interactions with Zn.

In this study, nevertheless, both types of composites are tested and compared their efficiency during removal of selected micropollutant representatives from waters.

Keywords: biochar, photocatalysis, sorption
Acknowledgement: This work was supported by the project TAČR no. SS06020124 supported by Technology Agency of the Czech Republic.

Using Passive Acoustic Monitoring to Detect the Presence of Various Mammal Species on Forest Clearings in The Republic of the Congo

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Congo Basin is among the most biodiverse areas on Earth and a stronghold for African megafauna; however, ongoing monitoring of wildlife populations testify their decline due to human encroachment. This project focuses on using acoustic recording devices, as a complementary approach for camera-trapping, to survey vocally active mammal species on four different mineral-rich forest clearings, so-called bais, in Messok-Dja in the Republic of the Congo. Audio data was obtained using AudioMoth devices set to record for the duration of approximately 30 days, which resulted in accumulating 1442 hours of recordings from the ends of dry seasons (Feb.-Mar., Aug.-Sep. 2022). The obtained audio files were sorted and labelled manually, finding 5 instances of assumed gunfire and 366 instances of vocal activity of 4 different species of mammals: 260 of mantled guerezas (*Colobus guereza*), 63 of chimpanzees (*Pan troglodytes*), 36 of western lowland gorillas (*Gorilla gorilla*), and of African forest elephants (*Loxodonta cyclotis*). The obtained data was classified into known types of calls (1 for guereza, 2 for chimpanzee, 2 for gorilla, and 2 for elephant), visualized and used to estimate diel activity patterns of the observed mammals. Comparisons of these patterns show evidence of avoidance of vocal activity of guerezas with its potential predator, the chimpanzee. Comparison with data from a concurrent extensive camera-trapping study revealed prominent diel partitioning of diurnal captures of guereza by cameras and nocturnal captures of calls by AudioMoths. The results show that passive acoustic monitoring is a useful complementary tool, especially for long-term automated monitoring of vocally active and

arboreal mammals in remote areas, and can be used as a reference for future possible monitoring projects in the Congo Basin. The recorded vocalizations also have potential as training data for the automation of the audio identification and classification process.

Keywords: passive acoustic monitoring, bai, activity, AudioMoth, Congo Basin, bioacoustics

Intermunicipal cooperation in the field of waste management and the environment

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The efficient provision of services in the field of waste management is importance not only for people's everyday life, but also for the finances of the local government. All municipalities, regardless of size, deal with waste on their territory. However, smaller municipalities usually do not have the opportunity to secure a more favourable contractual relationship with a waste collection company. Intermunicipal cooperation is a solution. For the municipality itself, it means economies of scale, lower costs, higher efficiency and availability of waste management services. Intermunicipal cooperation also focuses on the environment. Here, it can have a very positive effect on achieving environmental results, particularly in reducing emissions. The aim of the research was to map inter-municipal cooperation in the field of waste management and the environment in the Central Bohemian and South Moravian Regions of the Czech Republic. Primary research was conducted with representatives of voluntary associations of municipalities (VAM) in both regions, where a questionnaire survey was carried out, which thematically focused on the motives and scope of inter-municipal cooperation and specific experiences in both areas. Subsequently, a content analysis of strategic documents selected by VAMs in both regions was carried out, the aim of which was to find out how inter-municipal cooperation is conceptually anchored in both areas. As part of subsequent interviews with VAM representatives, this information was verified and compared with the reality. The interviews concerned benefits, barriers, motivations and approaches to inter-municipal cooperation in both fields. The analysis and interpretation of the results was evaluated based on the themes using descriptive statistics. A clustering classification technique was used to collect clusters of data with mutual similarity. Examples of good practice with projects in both fields are also enriching. The results of our own research were discussed with foreign studies to identify similarities, differences and transferable recommendations for improving the current situation.

Keywords: environment, inter-municipal cooperation, waste management

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Optimization of brewer's spent grain hydrolysis for biotechnological applications

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Breweries generate a huge amount of waste and the brewer's spent grain (BSG) represents its largest fraction. Although BSG is considered a by-product of the brewing process, it is simultaneously classified as a food-grade material. This by-product is rich in lignocellulose and proteins, making it a promising source of nitrogen and carbon for the cultivation of microorganisms.

The carbohydrates present in BSG are in the form of a compact polymer structure and therefore mostly unusable by microorganisms, which is the reason we aimed on the hydrolysis. We attempted to optimize the hydrolysis of BGS to produce a nutrient medium supporting the proliferation of microorganisms.

We investigated various conditions of the pretreatment of BGS, which included milling and non-milling of the BSG, as well as two different temperatures (80°C and 121°C) at which the BSG was pretreated. Furthermore, acidic, alkaline, and hydrothermal hydrolysis were tested along with the solid load of the BSG. The analysis was performed on two types of BGS, i.e. alcoholic and non-alcoholic beer production. We evaluated the amount of released carbohydrates.

According to our results, alkaline and acid hydrolysis turned out to be more applicable than the hydrothermal hydrolysis. The processing methods (80°C for 20 hours or 121°C for 20 minutes) as well as higher degree of milling did not have a significant impact on the final amounts of released carbohydrates. Regarding the solid load, the highest amounts of carbohydrates were released when using 10 % (w/v) of substrate per liquid solution. A larger amount of released carbohydrates was detected in BGS from alcoholic beer production.

In conclusion, the highest concentrations – 12.9 g/L (glucose), 19.1 g/L (xylose), 9.7 g/L (arabinose) – of released carbohydrates were achieved under following circumstances: BGS from alcoholic beer production, milled BGS, acidic hydrolyses (1.2% H_2SO_4), pretreatment at 121°C for 20 minutes.

Keywords: brewers' spent grain (BSG), hydrolyses, carbohydrates

Acknowledgement: The research was supported by the TACR NPO project no. TN02000044/01.

Dynamics of Runoff from Impermeable Surfaces

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The study addresses the dynamics of runoff from impermeable surfaces in urban areas, which are increasingly affected by climate change leading to more intense precipitation events. The goal of the work is to introduce, test, and quantify adaptation options for existing solutions to precipitation-runoff processes for heavy and extreme precipitation events, utilizing the Time-Area method, in urbanized zones. For this purpose, an alternative simulation model was designed and built, which was compared with the traditional Time-Area approach. The results of the work suggest that the alternative model offers significantly greater adaptability to heavy and extreme precipitation and provides a more robust tool for urban drainage planning. Thus, this work contributes to a better understanding of runoff dynamics in urban areas and offers innovative approaches for their resolution in current and future climatic conditions.

Keywords: urban drainage, simulation models, initial loss, Time-Area method, heavy and extreme precipitation

Comparative analysis of biodiversity in primary and managed forests: Lichen diversity and forest age structure in the Carpathians

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Anthropogenic activities have led to the loss and fragmentation of Europe's primary forests, intensifying biodiversity decline, especially among species dependent on unique forest structures. Comparative studies between primary and managed forests in Europe are scarce, and the understanding of the impact of forest management on species richness and the presence of red-listed species is limited. To address this gap, we conducted a comparative study using a unique dataset of permanent study plots established in well-preserved, mixed beech-dominated primary forests and their adjacent managed counterparts in the Carpathians. We assessed the impact of forest age—determined through dendrochronological tree-ring reconstructions—and forest structure on the abundance of both epiphytic and epixylic lichen species as a model group, which includes multiple forest continuity indicators and red-listed species. Lichen species richness was 30% higher in primary than in managed forests, whereas the richness of red-listed species in primary forest exceeded count in managed forest plots by 51%. Mixed modelling demonstrated a positive effect of tree age and the diameter of dead trees on species richness. In contrast, the basal area of living trees had a negative impact, likely due to reduced light availability. While the primary/managed forest factor significantly influenced overall species, it had no significant effect on red-listed species richness, where structural variables solely scored significant explanatory value. Our findings underscore the vital role of primary forests in biodiversity protection and the importance of forest structures, such as large deadwood, varied canopy closure, and old trees, typically found in old-growth and primary forests. Results suggest that with

careful, low-intensity management—preserving these structures—managed forests can promote biodiversity while also achieving economic goals.

Keywords: Species richness, Lichens, Primary forest, Forest management, Forest structure

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The Diet of Tengmalm's Owl (*Aegolius funereus*) in the changing environmental conditions in the Jizera Mountains

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The diet and food strategy of Tengmalm's Owl (*Aegolius funereus*) shows significant geographic variation across Europe. In Scandinavia, it is a nomadic predator specializing in voles, while in Central Europe it adopts a more opportunistic, generalist approach. Its food niche increases from the north to the south, except in regions with highly uniform environments. The study area is the Jizera Mountains, situated in "Black triangle" in Central Europe, where the forest ecosystems were damaged by air pollution in the end of 20th century and big successive changes occurred after the reforestation. At the start of the 21st century, Tengmalm's Owl thrived in open grasslands with abundant prey and enhanced nesting opportunities provided by artificial nest boxes. However, habitat succession has since transformed these areas into dense spruce forests, leading to shifts in prey availability and changes in the owl's diet composition. The study analyzes owl pellets from two periods, 2001-2002 and 2022 onward, to assess changes in diet. During the first period, 15 small mammal species were identified, with the Field Vole (*Microtus agrestis*) being the dominant prey. In peak vole years, voles constituted nearly 75% of the diet, but forest species (Yellow-Throated Mouse, Bank Vole) prevailed during years of low vole populations. The owl's diet in the Jizera Mountains 20 years ago resembled patterns observed in Scandinavia, with a higher vole presence compared to other Central European regions. Preliminary results from the second period suggest a shift in diet, with forest species now dominating and the Field Vole nearly absent. The owl demonstrates significant dietary flexibility, adapting to changes in prey availability by exploiting different resources depending on the surrounding environment.

Ecological Niches and Biogeography of European Mycoheterotrophic and Carnivorous Plants

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Mycoheterotrophic and carnivorous plants are specialized species that have evolved unique adaptations to obtain nutrients, including carbon, through alternative means – bypassing the need for photosynthesis or standard soil absorption. These adaptations enable them to thrive in specific habitats. This study aims to uncover the ecological niches and distribution patterns of mycoheterotrophic plants across Europe.

Using data from the European Vegetation Database (EVA), we developed a Boosted Regression Tree (BRT) model to predict the ecological niches of various mycoheterotrophic and carnivorous plant taxa. The model integrates environmental variables and species occurrence data to identify key factors influencing the distribution of these plants, including climatic, topographic, and habitat-related variables. The resulting distribution maps and niche models provide a comprehensive overview of the areas where mycoheterotrophs and carnivorous plants are most likely to occur.

Preliminary results for mycoheterotrophic species indicate that many taxa show a positive correlation with summer precipitation. Obligate mycoheterotrophic plants are more frequently found in shaded, less open habitats with lower mean summer air temperatures, while ectomycorrhizal taxa are more common in rugged terrain, as indicated by the terrain ruggedness index. Ongoing analyses for carnivorous plants are expected to show strong responses to climatic conditions and specific habitat preferences. These insights contribute to our understanding of biodiversity and the complex interactions within ecosystems, emphasizing the importance of conserving these unique plant-fungal and plant-insect associations.

Keywords: mycoheterotrophy, carnivorous plants, biogeography, niche modeling, BRT

Monitoring of dust storms and their impacts on air quality in Northeast Iceland and the Arctic

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Dust storms pose a threat to human health, aviation, safety, and the environment in general. Preliminary findings from an ongoing bachelor's thesis research focus on the analysis of measured dust particles (mass concentration of particulate matter (PM) — PM_1, $PM_{2.5}$, PM_4, and PM_{10}) in the area of Northeast Iceland. The data were acquired in the settlement of Grimsstadir, near the Dyngjusandur desert, Dyngjusandur desert itself, and during field trips (at several testing points) using the aerosol monitor DustTrak DRX 8533 EP (TSI Incorporated, USA). We examine whether the measured PM concentrations are significant in their levels and if they exceed recommended limits, such as the revised guidelines issued by the World Health Organization in 2021. We are also investigating how far the dust from Iceland has traveled, for which the HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) model, used to compute air parcel trajectories, can be applied. Satellite images from NASA's MODIS (Moderate Resolution Imaging Spectroradiometer) sensors can be used for comparison with the obtained data. Further insights will be provided by the DREAM (Dust Regional Atmospheric Model) meteorological dust forecast model for the Iceland region. Additionally, we have photographic evidence of a dust storm that occurred in Modrudalur in September 2022, which caused significant damage to several cars.

Keywords: PM, dust, measurements, air pollution, DustTrak

Cumulative effects and tolerable leve of nature's load: New challenges for environmental management

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The article discusses Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) in this context, highlighting the growing importance of cumulative impacts and the need for more robust frameworks to manage them effectively. As the global population grows, pressure on natural resources increases, and environmental degradation caused by human activities often exceeds the regenerative capacity of ecosystems. The study emphasizes the importance of sustainability in planning and decision-making processes, where integrating environmental aspects is essential to achieving long-term goals.

EIA, a fundamental environmental protection tool, originated from the National Environmental Policy Act (NEPA) of 1969 in the United States and has since been adopted globally, including in the Czech Republic, where it is regulated by Act No. 100/2001 Sb. While EIA aims to predict and mitigate ecological damage caused by individual projects, cumulative impacts—the combined effects of numerous smaller actions—pose a unique challenge. These impacts, though individually insignificant, can collectively cause significant environmental damage. The complexity of predicting cumulative impacts arises from the dynamic nature of ecosystems, the diversity of human activities, and the lack of comprehensive data and methodologies for accurate assessment.

The concept of Cumulative Effects Assessment and Management (CEAM) has become a key tool for understanding and managing cumulative environmental effects over time. CEAM provides a structured framework for assessing interactions between different stressors and their combined impacts on ecosystems. This approach helps policymakers

and developers identify threshold levels at which cumulative impacts become significant, enabling more effective mitigation strategies. The article discusses various methodologies for calculating cumulative impacts, such as spatial analyses, ecosystem services modeling, and system dynamics models, highlighting the need for continuous improvement of these tools to address the complexity of real-world interactions.

Furthermore, the study examines the concept of carrying capacity, which defines the maximum load ecosystems can bear without suffering irreversible damage. This concept is particularly relevant in regions affected by intensive industrial activities, where cumulative impacts often exceed the carrying capacity, leading to long-term ecological damage. Assessing carrying capacity within EIA is crucial to ensuring that development projects do not overwhelm ecosystems beyond their limits, thus promoting the sustainable use of natural resources.

In conclusion, the article emphasizes the need to update environmental policies and tools to reflect the complex realities of the Anthropocene. As cumulative impacts become increasingly prominent, there is a growing need for integrated assessment frameworks, such as CEAM, that consider both environmental and socio-economic factors. The study calls for greater stakeholder engagement, improved data collection, and adaptive management strategies to enhance the effectiveness of impact assessments in supporting sustainability. Integrating these approaches into broader planning processes is essential for mitigating long-term environmental degradation and ensuring a balance between development and ecological protection.

Keywords: EIA, cumulative effects, sustainability

The performance of constructed wetlands for the treatment of greywater: the contribution of biochar and mycorrhiza inoculum

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Environmental-friendly materials like biochar are considered to be a sustainable and green technology for greywater treatment in nature-based systems of constructed wetlands (CW). However, the biochar's removal efficiency of toxic pollutants in greywater is not well-known in CW. This study aimed to evaluate the removal efficiency of organic pollutants and surfactants in grey water by the biochar addition with live mycorrhiza and their effects on physiochemical parameters, nutrients and elements composition in CW system. The experiment was conducted in an outdoor column system from July to November 2022. Commercial substrate (Florcom SSI from BB Com s.r.o., Czech Republic) was employed to fill the columns to a height of 70 cm in CW. Selected columns were additionally treated with mycorrhiza inoculum (4.5% v/v; sterilized mycorrhiza as a control) and 10% (v/v) of Spruce biochar made at a pyrolysis temperature of 600°C while The entire column were planted with *Iris pseudocorus*. The columns were fed synthetic greywater that had been loaded with elements precisely (Ni, Cu,Zn, and B), anionic surfactant (2.5 mg/L), and 16 organic micropollutants (at concentrations of 10 to 50 g/L). It is concluded that removal efficiency of organic pollutant, surfactants and physiochemical parameters was higher for all the treatments except artificial sweeteners (Saccharin (>77%)) and Anionic surfactants (71%) and physiochemical parameters (TOC, TN and B), which were removed with low concentration. The intensive green roofs with the examined substrate offered very high

removal for organic micropollutants (>95%). The system's design, which did not encourage denitrification, was the reason for the low removal of total nitrogen. The removal of most of the pollutants (surfactant, saccharin, TN, TOC, N-NH4, Cu, Ni, P, B) was substantially and positively affected by biochar). In contrast some pollutants (Ni, Zn, N-NH4 benzotriazole, DEET, diclofenac, and ibuprofen) were removed more effectively with active mycorrhiza.

Key words: biochar, greywater, nature-based solutions, organic micropollutants, Constructed wetland, mycorrhiza

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GridRuler-ImageJ plugin for fungal spores concentration measurement

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In phytopathology, the measurement of spore concentration in suspense is crucial for monitoring pathogen load, assessing infection risk and standardizating of experimental conditions. Although modern machines for automatic object counting exist, they remain expensive, making manual counting in Bürker chamber the only viable option. To address this, we developed a plugin for imageJ, an open-source image processing software widely used in scientific research, that automates the counting process. While current image processing methods can count the object in images, our script uniquely identifies the Bürker chamber in an image, count the cells within the grid and even recognize them based on their size measuring their dimensions in real units. The plugin first detects the lines of the Burker chamber, identifies the larger square based on smaller ones and calibrates the image scale according to the actual grid size. With this calibration, plugin can count the spores in the image based on their size and also characterize their size. It process all images within the input folder generating outputs that include a table of concentration from all analyzed images, a table of size of measured spores and calibrated images in original, grayscale and binary form.

Keywords: Burker chamber, Image processing, counting of spores

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The effect of seasonality on resource use by large fauna in the Afrotropics

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Resources play a key role in shaping the spatio-temporal distribution of organisms at both species and individual levels. This project investigates the activity of endothermic vertebrates across several Afrotropical sites, including the seasonal savannas of southern Africa and the tropical rainforests of the Congo Basin. With an extensive use of camera traps, we examine how resource variation affects the ecology of large fauna and the spatio-temporal activity of individual animals in response to seasonal changes. In South Africa, we focus on the use of water sources by human introduced community of ungulates and other mammals in a small, fenced reserve dominated by shrubland savanna. In this environmental setting, where the large predator guild is incomplete, we show that ungulate visitation to water sources is influenced by body size and seasonal changes in (a)biotic factors. Species smaller than 100 kg primarily visit water sources during the day, while larger species visit them both during day and night. Seasonally, the presence of juveniles drives increased daytime activity, while higher maximum daily temperatures shift activity toward cooler hours, typically around sunset. Temporal segregation occurs based on feeding strategies, while spatial segregation is linked to water body types. In Congo, we explore the spatio-temporal occurrence of animals at natural clearings (bais) in the tropical rainforest. These bais serve as critical sites for resource acquisition, particularly mineral-rich clay, and for social interactions. Our objectives are to understand primal and complete mammalian community associations and how they fluctuate with resource availability and seasonal changes.

Keywords: seasonal variation, camera traps, Africa, savanna, tropical rainforest, bai, resource variation, spatio-temporal activity, water sources, minerals

Acknowledgement: Our thanks go to our partners in the field, explicitly to Mogalakwena Research Centre in South Africa, World Wildlife Fund (WWF) Republic of Congo, Congolese Agency for Wildlife and Protected Areas (ACFAP). Acknowledgements also go to Mobility Fund of Charles University for financial support, and to our collaborators and colleagues (Arthur Sniegon, Stanislav Lhota, Ondřej Peč, Anna Zelená Kubátová, Vojtěch Brlík, Florencia Grattarola, and more) for help with data collection, statistics, methodology, and logistics.

Introducing DendRobot: An Automated Pipeline for Forest 3D Scan Evaluation

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Accurate forest structure assessment is important for ecological research and sustainable forest management. Hereby DendRobot is presented, an innovative software pipeline developed to automate the evaluation of forest plots or entire stands using terrestrial LiDAR scans. DendRobot employs trusted algorithms to process 3D LiDAR data, delivering essential forestry metrics such as Diameter at Breast Height (DBH), tree height, and spatial attributes of individual trees. The software can also segment individual trees from point clouds and generate Digital Terrain Models (DTM), Digital Surface Models (DSM), and Canopy Height Models (CHM) with user-defined precision.

DendRobot should serve as a comprehensive tool for researchers and forest managers, enabling efficient, data-driven decision-making with minimal manual intervention. Initial tests conducted in complex forest environments demonstrate the pipeline's ability to streamline workflows and produce large-scale forest inventory data, achieving accuracy comparable to other state-of-the-art methods. The detection rate for individual trees exceeds 94 %, with DBH estimates reaching a mean absolute error (MAE) of 3.94 cm and a relative root mean square error (rRMSE) of 36 % for the top 95 % of results. For the top 80 %, MAE improves to 1.41 cm, with an rRMSE of 9.5 %. Tree height estimations show similarly impressive performance, with MAE of 1.12 m and rRMSE of 10.2 % for the top 95 %, and an MAE of 0.52 m and rRMSE of 3.28 % for the top 80 %.

Looking ahead, DendRobot aims to incorporate tree species classification, support for iPhone LiDAR scans and terrestrial photogrammetry, and enhanced filtering algorithms for more accurate DBH estimation, further advancing its capabilities in forest monitoring.

Keywords: forest inventory, LiDAR, MLS, diameter at breast height (DBH), tree height

The Role of Viewpoints in Landscape Planning: The Current Approach of Municipalities with Extended Competence

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Viewpoints are essential in addressing spatial development and preserving significant landscape values. In the Czech Republic, viewpoints are recorded at the level of municipalities with extended competence. These municipalities utilize viewpoints to assess landscape character impacts, conduct causal evaluations of construction impacts on the landscape, and perform preventive assessments to protect the landscape's visual integrity. With the development of 3D models, cities are exploring the potential of these technologies to define and evaluate the aesthetic values of the landscape. To serve as reference points for other visual phenomena, well-defined and suitable viewpoints are necessary for this purpose. This research has shown that although most municipalities have or have had viewpoints identified in the past, the quality and level of elaboration varies considerably. Furthermore, the new Construction Act has removed viewpoints from the list of mandatory monitored elements in municipalities' territorial analytical documents, which could exacerbate the current lack of data. This study presents an overview of the possibilities for utilizing defined viewpoints in spatial planning and offers an insight into the current approach of municipalities with extended competence to defining significant viewpoints, particularly within the scope of territorial analytical documents and landscape studies. The project surveyed municipalities with extended competence in 4 regions of the Czech Republic: the South Moravian, Moravian-Silesian, Olomouc and Zlín regions. The total sample consisted of 69 municipalities. The results are supplemented with overview maps in GIS.

Keywords: viewpoints, spatial planning documents, landscape character

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Acoustic monitoring of bats in old forest outside strictly protected areas in the Czech Republic

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Scattered remnants of old forest patches (>130 years) outside of strictly protected areas constitute a scarce habitat in the fragmented Central European landscape. Old forest patches in heavily transformed forest landscapes could support species dependent on old-growth forest characteristics. However, their potential role as biodiversity refuges to complement protected forests is poorly understood. Most European bat species rely on forest habitats during some stage of their life cycle, either as foraging habitats or for finding suitable tree roosts. Both foraging conditions and roost availability are shaped by forest structure. Old-growth forests, in particular, can provide crucial habitat features for bats, such as abundant tree-related microhabitats, standing dead trees, and high structural heterogeneity. Using ultrasonic acoustic recording devices, we monitor bat communities in different forest types along a forest age gradient in 73 old forest patches dispersed over Czechia. Together with an extensive collection of data describing structural forest parameters, we intend to disentangle how bats respond to differences in the forest structure, age, and composition. Old forests with abundant tree microhabitats and forage seems to be important habitats supporting bat diversity in our landscape.

Keywords: bats, old forest, bioacoustics

Man-made habitats as ecological traps for dragonflies

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Anthropogenically induced environmental changes have occurred in such a short evolutionary time, that organisms cannot adapt to these changes. Consequently, they can face habitat selection challenges exacerbated by human activities leading them to a preference of suboptimal habitats, despite the fact they are using verified cues. At this point, these man-made habitats can inadvertently act as ecological traps. The aim of our research was to assess the impact of human activities, namely fish farming and habitat restoration on dragonflies (*Sympetrum* spp.). We compared the body condition and mortality of larvae reared in (semi-) natural habitats (oxbow lakes and ponds without management) with those in man-made habitats (restored post-mining areas, intensive fish-farming ponds). The experiment was conducted in three main localities in the Czech Republic: the Sokolovsko region (where we assessed the effect of restoration after coal mining on dragonflies), Polabí (the effect of restoration after sand mining) and South Bohemia (impact of fish farming). Our findings indicate that natural localities are usually more diverse, containing both high- and low-quality habitats. In contrast, man-made localities are more uniform providing only sub-optimal conditions for larvae, which was reflected in high mortality and poor body condition of larvae.

Keywords: freshwater invertebrates, freshwater habitats, body condition of dragonflies

Annual activity of the African forest elephant at Dibo bai, Republic of the Congo

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African forest elephants (*Loxodonta cyclotis*) act as ecosystem engineers within the Congo basin by dispersing seeds, creating a network of trails, or modifying and maintaining forest clearings typically rich in minerals and known as "bais". Here, elephants and other species supplement their deficiency of nutrients through geophagy or grazing plants, as well as utilizing the open space in the forest for social interactions. Understanding the visitation pattern of elephants at bais provides an important baseline for the assessment of the local elephant population, their dietary requirements, diel activity pattern and conservation. Our project targeted annual changes of visitation and activity of elephants at Dibo bai located in the northern Republic of the Congo. The first extensive camera-trapping study conducted at bais in a core zone of the Messok-Dja conservation area between February 2022 and February 2023 focused on elephants and other wildlife occurring at every potentially active mineral deposits found at bai and in its vicinity. In total 43,947 images of elephants resulting in 730 independently captured events enabled us to identify the monthly visitation peak of elephants in the wet season in April and May, preference in the use of ecotone around the bai, dominantly nocturnal activity with no significant changes across seasons and habitat and prolonged duration of visits in the wet seasons and under the canopy of the forest edges. Based on visually distinctive features we were able to identify 27 elephants, to create a catalogue and to trace their revisits at the bai mainly in October and November. The secretive activity pattern exhibited by elephants imply avoidance of potential disturbance by humans. This study has laid the foundations

for any future long-term monitoring array across all bais in the area, which should provide previously lacking data of a high conservation value not only from Messok-Dja but also for the entire Tridom landscape known as the African forest elephant stronghold.

Keywords: bai, activity, elephant, camera trap, Congo Basin, monitoring

The Steinach Grassland Experiment: The Influence of Decades-long Fertiliser Application on the Content of the Accumulation of Trace Elements Fe, Zn, Cu, Mn, Al, As, Cr, Ni, Pb, and Cd in Soil

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The contamination of soil with potentially toxic elements, especially heavy metals, remains a critical concern for agricultural sustainability, food safety, and human health due to their toxicity, persistence in the environment, and tendency to bioaccumulate. Long-term studies involving fertilisation practices offer vital insights into how different fertiliser applications influence soil chemistry, plant diversity, crop productivity, and forage quality. The Steinach Grassland Experiment (SGE), established in 1933 in Southeast Germany, is likely the longest ongoing grassland fertilisation trial in Continental Europe, conducted on an alluvial meadow dominated by Alopecurus pratensis. This study investigates the impact of prolonged nitrogen (N), phosphorus (P), and potassium (K) fertilisation on the accumulation, mobility, and potential bioavailability of harmful elements in the soil. Various soil extraction methods were used to assess bioaccessible, easily mobilisable, potentially mobilisable, and total element content. Notably, long-term phosphorus fertilisation was linked to increases in Fe, Zn, Cu, Mn, As, Cr, and Cd. Nonetheless, regulatory limits for trace elements were exceeded only in the cases of As and Cd. The heightened arsenic levels may be associated with the historical use of Thomas slag as fertiliser, while the rise in chromium was observed in plots treated with ammonium sulfate ($(NH_4)_2SO_4$).

Keywords: fertilisation with N, P, K, arsenic, cadmium, mobility, accumulation

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The impact of composting additives on risk metal(loid) behaviour in sewage sludge and amended soil

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This research investigates the behaviour and mobility of toxic metal(loid)s in raw sewage sludge and its composted forms with various additives, as well as in soil samples amended with these materials. The aim was to assess the appropriate composition of the compost to prevent the release of contaminants from the sludge.

For this purpose, three standardized leaching tests were employed: the Toxicity Characteristic Leaching Procedure (TCLP), the Synthetic Precipitation Leaching Procedure (SPLP), and ČSN EN 12457-4 for the leaching of granular waste and sludge. These procedures were chosen to imitate various environmental conditions, enabling the evaluation of the possible release of toxic elements into the environment. The study compares metal(loid) concentrations in raw sewage sludge and composted sewage sludge enhanced with coarse chips and biopreparation.

All composted variations met the EU regulatory limits for leaching from non-hazardous waste as outlined in Council Decision 2003/33/EC. However, the behaviour of As, Cd, and Pb emphasized the need for further careful monitoring. After application of the composted sludge variants in soil, the results from the leaching tests indicated that metal(loid) concentrations varied based on the composting additives applied. Specifically, TCLP results demonstrated that soils treated with biopreparation showed increased levels of Zn, Cu, and Pb, while Ni was most prevalent in untreated soils. The SPLP results supported these findings, revealing that biopreparation—whether combined with coarse chips or not— increased the mobility of Zn, Cu, and Ni; Pb concentrations were highest in non-amended soils. A similar pattern follows from the EN 12457-4 test, where peak concentrations of Zn, Cu, and Pb were recorded in soils amended with biopreparation, while Ni remained highest in non-amended soils. These outcomes imply

that both biopreparation and coarse chips may influence either retention or mobility of specific metal(loid)s in the simulated environmental scenarios of each leaching test.

The research highlights how composting techniques and additives significantly affect metal(loid)s mobility. Notably, biopreparation seems to play a crucial role in affecting Zn, Cu, and Pb behaviour within soil environments potentially increasing their mobility. This investigation stresses the necessity for optimizing composting procedures and reasonably selecting additives to minimize leaching risks associated with potentially toxic metal(loid)s. Furthermore, our findings provide essential insights for improving composting practices to comply with environmental regulations and mitigate risks to ecosystems. Additional research is advised to (a) formulate sustainable waste management approaches that focus on reducing the release of hazardous elements and (b) examine the long-term behaviour of these elements within composted materials along with their prospective ecological consequences.

Keywords: risk metal(loid)s, metal mobility, soil remediation, toxic metal leachability, composting additives, sludges

Changes in clostridial viability and metabolism induced by lignocellulosic inhibitors

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Renewable lignocellulosic biomass has the potential to serve as a valuable source of sugars for the sustainable production of chemicals. However, its efficient utilization is challenging due to the complex, tightly-bound matrix of cellulose, hemicellulose, and lignin, which makes both separation and hydrolysis processes complicated. Various methods have been developed to release fermentable sugars from lignocellulosic biomass, but these approaches often generate inhibitory by-products. In this study, we investigated the impact of ferulic acid, coumaric acid and their synergistic interaction on the viability and solvent production of *Clostridium beijerinckii* NRRL B-598. In the presence of ferulic acid (0.4 g/l), higher solvent concentrations were achived, while cell viability was prolonged and the level of sporulation remained unchanged. In the case of coumaric acid (0.3 g/l), a low concentration of solvents was produced, and the number of spores was minimal. Similar results were obtained with the addition of both ferulic and coumaric acids (0.2 g/l each); solvent concentrations and spores counts remained the same as those seen with coumaric acid alone. However, when using longer-grown culture, a different metabolic profile was observed even with a higher concentration of ferulic and coumaric acids (0.3 g/l each). Through this work, we demonstrated the impact of various inhibitors on solventogenic strain of *Clostridium* and how to mitigate their negative effects by using cultures at a different growth stages.

Keywords: *Clostridium* beijerinckii, lignocellulosic biomass, inhibitors

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Rewilding Beech-dominated Temperate Forest Ecosystems: Effects on Carbon Stocks and Biodiversity Indicators

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Maximising carbon stock and habitat availability is a critical objective of contemporary forest management, with primary forests serving a crucial function due to their substantial carbon storage potential and biodiversity values. Given the limited extent and fragmentation of primary forests in Europe, there is growing interest in understanding how rewilding (long-term management cessation) affects carbon stock and habitat provisioning. Further, little is known about the conditions required for secondary old-growth forests to achieve the carbon volumes and late-successional habitat features associated with primary forests if designated as rewilding areas. We compared some of the best-preserved primary old-growth forests with adjacent secondary old-growth forests allowed to undergo self-development for an extended period of seven decades in the ecologically and socially important beech-dominated forests of the Carpathian Mountains. Statistical analysis showed no significant

differences in carbon stock and structural biodiversity indicators between the two forest categories. Mean aboveground carbon stock was 207 Mg ha^{-1} in primary and 213 Mg ha^{-1} in secondary old-growth plots, which contrasts with values of 107 Mg ha^{-1} found in managed beech forest stands from the same region. The aboveground biomass carbon increment was 4.3 Mg ha^{-1} $year^{-1}$ in primary and 4.5 Mg ha^{-1} $year^{-1}$ in secondary plots, respectively. Notably, deadwood volume exhibited the most substantial variation among forest types along with tree microhabitat diversity. Our findings underscore the vital role of protecting and restoring old-growth forest ecosystems for effective carbon stock and biodiversity conservation. We emphasise that forest heterogeneity, encompassing factors such as tree age and diameter, canopy layer, species composition, and growth patterns, are important for enabling managed forests to reach peak carbon storage capacity. Although 70 years is insufficient for secondary old-growth forests to fully recover primary forest characteristics, our study demonstrates that similar structures and functions can develop within less than a century of protection in productive temperate regions of Europe. This study supports rewilding as an effective conservation strategy and Natural Climate Solution.

Keywords: carbon stock, Carpathian Mountains, secondary old-growth forests, deadwood, tree microhabitats, restoration, large trees

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Invertebrate biodiversity in bryophyte habitats: epigeic vs. epiphytic bryophytes

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Bryophytes provide favourable habitats for many invertebrates. In this study, we determine whether the composition, density, and richness of invertebrates differ between epigeic and epiphytic bryophytes. Within epiphytic bryophytes we aimed to identify key factors affecting the aforementioned parameters, including the influence of substrate type, bryophyte moisture, and vertical gradient.

Our research involved sampling from 834 plots across 56 locations with 240 plots for epiphytic bryophytes and 594 plots for epigeic bryophytes. The invertebrates were collected from the plots using manual sorting.

The findings revealed distinct invertebrate compositions in these environments. Epigeic bryophytes predominantly harbored *Formicidae*, *Diptera*, and *Araneae*, whereas epiphytic bryophytes predominantly harbored *Collembola*, *Araneae*, and *Isopoda*. *Formicidae* and *Diptera* were significantly more prevalent in epigeic bryophytes, whereas *Collembola* in epiphytic ones. Regarding bryophagous invertebrates, *Byrrhidae* beetles were dominant in epigeic bryophytes, contrasting with bryophagous moth larvae dominating epiphytic bryophytes. The study also noted seasonal variations, with a decrease in the overall density and richness of invertebrates during the summer months, followed by an increase towards the end of the season.

Formicidae and *Diptera*, dominant in epigeic bryophytes, were more frequently found at lower heights in epiphytic bryophytes, whereas *Araneae*, prevalent in epiphytic bryophytes, were located higher. Furthermore, *Formicidae* and *Byrrhidae* beetles respond positively to bryophyte humidity, whereas *Dermaptera* and bryophagous moth larvae show a preference for the driest bryophytes.

This research enhances our understanding of invertebrate distribution in bryophytes. The interconnection between invertebrate composition, their distribution along the vertical gradient, the content of secondary metabolites, and water stress in bryophytes remains to be investigated in future research.

Keywords: community composition, vertical gradient, humidity, seasonal variation

Drones in wildlife research: advantages and limitations

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Monitoring animal populations is crucial for their effective management, tracking invasive species and understanding habitat requirements. Traditional ground surveys are usually expensive and time-consuming and often cannot reach difficult areas, such as the ones with dense vegetation or with dangerous conditions. Remote sensing can address these issues, especially drones, that can provide high spatial resolution data showing a wide range of applications from agriculture and mapping to wildlife monitoring. They provide a non-invasive method to collect reproducible and standardized data, due to their ability to autonomously follow pre-programmed flight paths while capturing geo-referenced images. The possibility to use multiple types of sensors and drones allows researchers to acquire diverse information regarding animal species in different environments. For instance, thermal sensors are particularly useful for monitoring crepuscular and nocturnal animals, or for enhancing the detection of arboreal species or birds' nests, while RGB cameras can be used for species identification and behavioural studies. Multirotor drones can take off and land in very small areas, but their flight time is short, while fixed-wing drones offer longer flight time and can cover larger areas, but require higher training experience and lack the ability to hover. The limitations of drones are related to their dependence on weather for the flight, limited battery life, the need for the optimal lighting conditions to ensure a proper alignment of the photos for the orthomosaics and the amount of time required for analysing the data. Despite these challenges, drones open up multiple opportunities in wildlife monitoring, such as species identification and population counts, especially for elusive species living in remote areas. Moreover, the integration of machine learning algorithms can significantly reduce the time required for the analysis, improving their overall efficiency.

Keywords: UAVs, remote sensing, wildlife monitoring

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Comparison of R Libraries for Population Size Estimation: Insights and Recommendations

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Population size estimation is a field that has developed over decades and has been greatly enhanced by recent advances in computer technology. These advances have introduced a variety of methods that have improved the accuracy of estimates. Our research focused on open population models, in particular the Jolly-Seber method and its adaptations within various R libraries. We analysed data from six butterfly populations, covering four species across different years and degrees of population 'openness'. This involved calculating abundance estimates and standard errors (SE) for each library, using generalised linear models for comparison and the Tukey HSD post-hoc test for detailed pairwise analysis. Additional characteristics of each library, such as computational time and ease of use, were also evaluated. Our results showed significant differences in overall abundance estimates, with the 'RMark' library showing the most overestimates and the 'marked' library showing the most underestimates. However, there were no significant differences in their SEs. Conversely, while the partial estimates showed uniformity across the libraries, their SEs varied significantly, with 'mra' having the highest and 'RMark' the lowest SEs. The variation in computational time was also significant, which has implications for library selection, particularly for larger datasets. Understanding these differences is crucial for selecting appropriate methods based on specific research or conservation needs.

Keywords: capture-mark-recapture, Jolly-Seber, open populations, butterflies, Lepidoptera, packages in R, comparison of methods, abundance estimates

The influence of vegetation structure on the selection of nesting sites by the Whinchats and Stonechats

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The research was realized at the locality Pod Benáteckým vrchem, a former training area on the northern from Milovice approximately five years after the army abandoned it. The site covers an area of about 250 hectares. Due to military activities, the expansion of shrubs was prevented, resulting in a very heterogeneous character of the entire area. There were large patches of uncovered vegetation (up to 20 %), which gradually began to be overgrown by ruderal vegetation. A fundamental characteristic of the area's vegetation was that the plant communities were not compact and variedly intermingled and alternated. There were also numerous elevated spots suitable for the Whinchats (*Saxicola rubetra*) and Stonechats (*Saxicola rubicola*) as perches (lookout points for hunting).

The selection of nesting habitat by the Whinchats and Stonechats primarily depends on the height and structure of the vegetation and seemingly very little on species composition. A total of 100 squares measuring 10 x 10 meters were evenly marked out across the site. In these squares, the coverage of vegetation at different levels above ground was mapped in detail during the arrival of Whinchats and again three weeks later, during the egg incubation period, along with the number of perches suitable for use by Chats for hunting and singing. Any site that exceeded the surrounding vegetation was considered a suitable perch. The results were used to compare the vegetation in nesting sites of both Chats species and places where these species do not nest. A total of 101 territories of the Whinchat and 16 territories of the Stonechat were identified.

For nests where I determined the location of the entire feeding territory (9 Whinchat pairs and 6 Stonechat pairs), the vegetation cover of the territory was mapped. It was

found that the character of the vegetation in the territories of these species did not differ significantly. Furthermore, the territories of these two species often overlapped in the monitored area. This indicates that vegetation cover does not seem to be a factor distinguishing these two species. A possible aspect that allows nesting in the same location for such closely related species could be the timing of nesting. The timing of nesting ensures that these two species, although nesting in the same place, avoid mutual competition during the feeding of their chicks.

Comparison of individual characteristics of vegetation cover across the entire locality indicates that significantly influential factors in the selection of territory for both species are the coverage of vegetation at heights of 30 - 50 cm and 50 - 70 cm, as well as the number of perches, both at the time of arrival and during the incubation of the clutches.

Keywords: whinchat, stonechat, habitat selection, military area

Exploring the diversity of Acarosporaceae: two new species of *Myriospora* from Central Europe

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Myriospora is one of the seven genera in the Acarosporaceae family consisting of crustose lichens. Despite more than 200 taxa described in the family in Europe, many species remain poorly understood and need modern taxonomic revision. In this study, we describe two new species of *Myriospora* from Central Europe. Integrative taxonomic analysis recovered *Myriospora hillitzeri* and *Myriospora marginata* as sister species differing in apothecial anatomy. *M. marginata* is characterized by an elevated thalline margin, while *M. hillitzeri* has immersed apothecia. Molecular phylogenetic analysis provided strong support for the recognition of these new species. The genus now includes 14 species, with new species identified from the Czech Republic and Germany.

Keywords: lichens, integrative taxonomy, molecular analysis, family

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Tissue and life-stage specific gene expression dynamics in the drywood termite, *Incisitermes schwarzi* (*Isoptera*: *Kalotermitidae*)

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Termites are eusocial keystone insect species that feed on wood matter and plants to obtain cellular energy. Certain invasive wood-feeding isopteran termite pests such as *Coptotermes* (Rhinotermitidae), *Macrotermes*, *Odontotermes* and *Microtermes* species (Termitidae) have caused immense damage to eucalyptus forests in Malaysia, Australia, India, China and Africa, due to increased wood decomposition sensitivity to warming temperatures, leading to global economic losses. Traditional forest pest management strategies have failed to curb these termite infestations, thereby urgently calling for the deployment of novel methods. A detailed understanding of the termite adaptation and physiology at the molecular level shall aid in development of future management measures utilizing molecular tools such as RNA interference (RNAi). In this study, we have selected the drywood termite, *Incisitermes schwarzi*, (Isoptera: Kalotermitidae) to investigate how these specific termites survive during their voracious feeding on spruce and birch deadwood in a drywood habitat. To understand their wood digestion response and detoxification behavior of the natural toxins present in deadwood, we have conducted gene expression analysis in different life stages and different tissues. Differential gene expression (DGE) analysis across developmental stages and tissue types, have revealed multiple gene families related to wood detoxification, wood digestion, growth and development of the termites, their eusocial behavior, and, adaptation to biotic and abiotic stress causing agents. Further, we have identified RNAi machinery genes and explored their expression dynamics across the different life stages and tissues in the drywood termites. The differentially expressed genes identified through this study could help in improving our understanding of termite adaptation to

their lignocellulosic habitats and could serve as excellent putative targets for RNAi-based termite management.

Keywords: termites, DGE analysis, digestion, detoxification, RNAi machinery gene expression, forest pest management

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Synergy of Traditional Land Management and New Technologies for Climate Change Mitigation

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Mitigating climate change requires innovative approaches that combine traditional land management practices with new technologies. Climate change, characterized by the melting of polar ice caps, rising sea levels, and extreme weather events, is an increasing threat to ecosystems and human well-being. This study conducted a meta-analysis of 36 primary articles (1990-2024) to assess how integrating new technologies with traditional land management practices can reduce climate impacts. Key outcomes included enhanced ecosystem resilience, increased carbon sequestration and soil carbon storage, reduced water stress, minimized environmental impact, and greater adoption of sustainable practices. The findings showed that integrated water management leads to climate change mitigation more than three other scenarios of integrated land management. The meta-regression results indicated that integrated water management could be useful for achieving enhanced ecosystem resilience (26%), increased carbon storage in soil (47%), and more adoption of sustainable practices (50%). Still, holistic soil management decreases ecosystem resilience (19%). Considering the spatiotemporal effects estimated by meta-regressions, the greatest effects are linked to increased adoption of sustainable practices by American countries for the location of the primary articles. Accordingly, improvement in integrated land management is recommended to improve carbon storage in soil at the global level. Policymaking only based on holistic soil management is not in favor of ecosystem resilience, hence, improving integrated water management is recommended for the ecosystem resilience and the protection of the environment.

Keywords: climate change mitigation; traditional land management; carbon sequestration; ecosystem resilience; sustainable land practices

Community dynamics of understory vegetation after clearcut logging across a 445-year chronosequence in the Siskiyou Mountains of southwestern Oregon, USA

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The conversion of natural forests to managed forests reduced the amount of older, structurally diverse forests worldwide. In the Pacific Northwest's (USA) conifer forests – where understory plants represent 90% of plant species richness but only 1% of forest biomass – the long-term impacts of timber harvesting remain unclear. We remeasured a chronosequence of forests in the Siskiyou Mountains, Oregon, initially sampled in 2003, using 13 plots (2,500 m^2) ranging from 25 to 445 years of age, to compare changes in plant communities in early seral logged stands with those in mature and old-growth conditions. In 2021, we resurveyed the understory to assess whether the relationship between stand structure, environmental attributes, and understory vegetation had shifted over the 18-year period. Our results support the non-linear relationship between stand age and richness observed in 2003, such that richness was highest in early seral stands, lowest in mature stands, then intermediate in the old-growth stands. Canopy cover increased in all stands, particularly in early seral stands (24%) as they transitioned into canopy closure, leading to the loss of 11 species on average and increased compositional similarity to mature and old-growth stands. Mature and old-growth stands showed declining evenness and diversity, driven by the increase in dominant shade-tolerant species. These results demonstrate a legacy effect of clearcut logging and fire exclusion on a critical component of forest biodiversity where plantations have entered a period of high canopy cover, low richness, and reduced diversity, while species diversity and evenness have declined in mature and old-growth stands.

Keywords: chronosequence; clearcut logging; species richness; understory vegetation; plant community; non-metric multidimensional scaling ordination

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Possible utilization of LCA principles to assess the impact of the ski industry and project its future development

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Mountain regions are unique ecosystems that necessitate protection while providing essential resources. Recent decades have seen significant transformations in these areas due to the expansion of tourism, particularly the ski industry, which has altered the character of many valleys. While tourism fosters economic opportunities linked to job creation, it also exerts considerable environmental impact. Recognizing the social changes at both local and broader levels is crucial, as mountain areas often become sites of contention among diverse interest groups with conflicting visions for development. This research seeks to develop a methodological tool to assess the positive and negative impacts of various stakeholders' activities. Grounded in Life Cycle Assessment (LCA) principles, the methodology evaluates immediate, localized effects and long-term global implications. The study proposes applications of specific LCA methods—i) Environmental LCA (E-LCA), ii) Social LCA (S-LCA), and iii) Life Cycle Costing (LCC)—and their potential integration into a comprehensive Life Cycle Sustainability Assessment framework. The practical component involves assessing the impacts of skiing in smaller resorts, using one tourist visit per day as the functional unit for calculations. Preliminary results highlight the comparative impacts of skiing activities against those associated with tourist transport and accommodation. Calculations are performed in an Excel model, allowing modifications to input parameters like artificial snow production and energy consumption for lifts and slope maintenance. Future adjustments to energy sources in the model aim to project potential changes in impacts. The research focuses on gathering additional data to refine these calculations and expand the scope to include other mountain activities, ultimately transitioning from Excel to the OpenLCA software environment.

Keywords: S-LCA, E-LCA, LCC, LCSA, mountain tourism, snowmaking, ski industry

What If...? What would happen to Balikpapan proboscis monkeys without the relocation of the Indonesian capital city?

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The population of endangered proboscis monkeys (*Nasalis larvatus*) in Balikpapan Bay portrayed stability in the last fifteen years before Nusantara, the new Indonesian capital, construction started in July 2022. We used VORTEX v. 10.5.6.0 software to run a population viability analysis for the Balikpapan Bay proboscis monkey population, utilizing the 2022 data to parametrize its predicted trajectory in the upcoming 50 years. Our model depicted proceeding stability for all six subpopulations in Balikpapan Bay under current conditions until at least 2072. Sensitivity testing highlighted parameters associated with female reproduction and infant survival among the most influential in the model. Therefore, subsequent studies on demography, with an accent on reproduction and infant sex ratio and survival rates are of utmost need. The alternative scenario of reforestation was evaluated as the most promising considering proboscis monkey survival and could take advantage of 45.33 km2 of potentially restorable habitat that was historically destroyed in Balikpapan Bay. Additional fragmentation of the whole population would only endanger the overall survivability of the majority of individual subpopulations if there is an introduction of hunting. Hunting was identified as the most dangerous factor with the highest chance of destroying the whole population. Continuation of currently bearable habitat loss still resulted in a stable proboscis monkey population, therefore devotion of the Indonesian government to a planned "*smart, green, beautiful, and sustainable city*" concerning the local environment should be a principal conservation goal for forthcoming years.

Keywords: population viability analysis, proboscis monkey, Balikpapan Bay, Nusantara

What's for dinner? The visual acuity in European cypriniform fishes

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Sight is a key sense for fish. While studying the photosensitive cell layer on fish retinas gives us information about their chromatic abilities, it is the ganglion cells that ultimately define the perception of the species' environment. Compared to overabundant photoreceptors, ganglion cells collect signals from the photoreceptor layer and mediate its transmission via the optic nerve to the central nervous system. In cypriniform fishes of Central Europe, we have previously reported that these fishes are tetrachromatic, with various degree of cone mosaics present on their retinas. Applying the Nissl staining on whole-mounted retinas, we investigated the presence of the highest ganglion cell densities, a proxy to potential visual acuity (the ability to resolve spatial detail) areas in 13 cypriniform species. In family *Leuciscidae*, we found a correlation between the feeding strategies and the position of these high-density areas. For example, the common roach (*Rutilus rutilus*) with terminal mouth has the highest ganglion cell density in lateral part of the retina. Species with superior mouth position have this area shifted along the lateroventral part of the retina, with some common bleak (*Alburnus alburnus*) individuals having the highest ganglion densities on lateral part. Compared to these condensed high ganglion cell density areas, investigated fish species from families *Cyprinidae* and *Xenocyprinidae* possess typically broader areas, located from the central part to the lateral. Interestingly, common nase (*Chondrostoma nasus*)and barbel (*Barbus barbus*) share a similar pattern of horizontal streak across the retina.

Keywords: vision, retina, ganglion cells, Cypriniformes, teleost fishes

I see you in green: The story behind RH2 opsin gene duplications in European cypriniform fishes from family *Leuciscidae*

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Vision plays a key role in life histories of many vertebrates, fish included. Arranged by a photoreceptor cell layer in retina, it allows for colour perception mediated by cones and scotopic vision in dim-light conditions mediated by rods. In cones, four types of opsin genes are expressed (SWS1, SWS2, RH2 and LWS), while one type is expressed on rods (RH1). Some cypriniform fishes acquired multiple copies of these genes during evolution (predominantly RH1 and RH2 opsins), they thus express alternative opsin combinations specific to different developmental stages of the fish. In this study, we focused on Central European cypriniform fishes predominantly from family *Leuciscidae* (14 species out of 22 studied), and we report the plasticity of the visual system comparing data of adults and juveniles of 11 species. In adults, the most abundant opsin in retina is the long wavelength sensitive LWS opsin, which may be a result of adaptation to a higher level of water turbidity in European rivers. LWS opsin gene is expressed on double cones on cypriniform fish retina where the other cone from the pair carries RH2 opsin. Larvae and juveniles, however, predominantly express shorter wavelength-sensitive opsins (SWS1, SWS2) as they linger close to the surface on shallow riverbanks. These short wavelength-sensitive opsin genes are expressed on single cones. Variable numbers of RH2 opsin gene copies were found among the studied fish, their duplications mostly independent on whole genome duplication events in teleosts. Our genomic data suggest a presence of five ancestral RH2 gene copies in family *Leuciscidae*, some of which diversified further in extant species. In other cypriniform fishes, we detected both ancestral and recent duplications of the green opsin gene.

Keywords: opsin, vision, cyprinid, teleost fishes, *Leuciscidae*

Utilization of new sterilization methods for introduction into *in vitro*

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Introducing woody crops into *in vitro* conditions poses challenges due to potential contamination from a wide range of pathogens on their surfaces. This study aimed to assess the feasibility of using dormant buds from selected fruit tree species for *in vitro* initiation and subsequent multiplication in bioreactors utilizing a temporary immersion system (TIS). Experiments were conducted with specific raspberry varieties cultivated in the hotbed of the Crop Research Institute in Prague. The *in vitro* regeneration method tested involved surface sterilization using chlorine-based disinfectants. Initially, uninodal bud segments underwent washing with tap water, treatment with commercial bleach, ethanol application, and final rinsing with sterilized water. Buds with approximately 1 cm of the attached twig were then placed on a semisolid modified MS medium containing 30 g L^{-1} sucrose, 1 mg L^{-1} BAP, 0.1 mg L^{-1} IBA, and 7 g L^{-1} agar. Newly sprouted shoots were subsequently transferred to bioreactors with the same medium composition, excluding agar. Growth of *in vitro* cultures and the response of other fruit tree species in the bioreactor system were evaluated. The proposed method demonstrates potential for use in the *in vitro* cultivation system of selected fruit tree species.

Keywords: fruit crop, *in vitro*, bioreactor

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Winter distribution of ground-dwelling arthropods and birds in wildflower strips and arable land: do agricultural practices matter?

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Agri-environmental schemes, such as wildflower strips, can help to mitigate biodiversity loss caused by agricultural intensification. Wildflower strips provide benefits like biodiversity support and soil protection, particularly during winter when they can offer crucial shelter for multiple species in agricultural landscapes. However, the impact of management activities, e.g., autumn mowing of wildflower strips or soil tillage in surrounding arable fields, on wildflower strip winter performance is poorly understood. This study explores how ground-dwelling arthropods and resident birds utilise wildflower strips and surrounding arable land during winter while evaluating the effects of different management practices. We investigated ten arable fields, either tilled or planted with winter crops, and adjacent wildflower strips split into mown and unmown sections. Wildflower strips significantly increased arthropod activity density, species richness, and bird abundance. However, no significant difference was observed in bird species richness. Carabids and rove beetles were primarily concentrated at the edge of wildflower strips, while spiders and myriapods were more abundant in the wildflower strips' interiors. Autumn mowing had no effects on the studied taxa. In contrast, soil tillage in arable fields negatively impacted carabids, spiders, and myriapods but positively affected rove beetles. This study highlights the importance of wildflower strips for supporting beneficial species during winter. At the same time, promoting winter crops can also benefit different arthropod groups. Wildflower strips represent a crucial solution for sustaining agroecosystems in arable land across seasons.

Keywords: agroecosystems, biodiversity, epigeic invertebrates, non-crop habitats, winter survival, birds

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Identifying activities leading to the worsening of the ecological status of the Botič Creek and proposal of restoration measures

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The paper analyses the ecological state of Botič Creek, the longest creek in central Bohemia and Prague, to identify the human activities driving its deterioration. The study examines key factors such as land-use changes, creek morphology alterations, and industrial, agricultural, and urban runoff pollution. It highlights the urgent need for restorative action to prevent further decline.

Methods used include historical water quality data analysis and mapping of land-use and land cover (LULC) changes from 2000 to 2018. Agriculture remains the dominant land use at 44.8%, while urban development has caused significant loss of natural habitats. The area lost to urbanization was 52.95% (2000 to 2006), and 20.7% (2012 to 2018), indicating a slowdown in urbanization. However, from 2006 to 2018, non-irrigated arable land conversions to construction sites, industrial units, and discontinuous urban fabric increased, suggesting future urbanization. Impervious surfaces cover 36% of the watershed, worsening stormwater runoff, water quality, and biodiversity. Site visits confirmed these findings and revealed the main contributors to the creek's decline.

The study used a weighted overlay analysis to identify problematic areas and propose restoration measures. Key recommendations include naturalizing creek channels, installing green infrastructure to reduce runoff, and focusing on natural solutions for highly urbanized areas. The analysis showed that the most vulnerable areas are downstream, with 78% impervious surfaces, while upstream areas remain dominated by agriculture, with 15% impervious coverage.

These insights emphasize the need for immediate restoration and preventive measures in areas not yet impacted. The research provides a strategic guide for local authorities and offers hope for Botič Creek's long-term recovery.

Keywords: watershed management, urbanization, Botič creek, anthropogenic activities, restoration

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Strategy for Rural Development in Colombia: Socio-Economic Analysis of Natural Rubber Plantations

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This research examines the strategic potential of natural rubber plantations as a catalyst for rural development in Colombia. It presents a detailed socio-economic analysis, focusing on how these plantations contribute to local economic growth, employment creation, and improving livelihoods in rural communities. By integrating field data with policy analysis, the study evaluates the sustainability of natural rubber as an agro-industrial activity and its scalability across different regions of Colombia. The findings highlight that while natural rubber plantations offer substantial benefits—including job creation and income diversification—their full potential can only be realized through coordinated policy frameworks, infrastructure development, and investments in education and technical training. The study addresses critical socio-economic challenges such as land tenure issues, environmental impacts, and the need to integrate smallholders into the value chain. The research provides actionable insights that contribute to Colombia's broader discourse on sustainable rural development, especially within agroforestry and economic diversification in post-conflict areas.

Keywords: Natural rubber, rural development, socio-economic analysis, Colombia, agroforestry

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Everything You Always Wanted to Know About Insect Ecology (Group) * But Were Afraid to Ask

Insect Ecology Group[1]

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Insects represent the most dominant part of biodiversity both in terrestrial and fresh water environments. They frequently interact with other organisms in complicated ways, resulting in spectacular as well as obscure relationships. Sometimes insect hosts are manipulated by their parasites and parasitoids, in other cases insects affect the functioning of whole ecosystems. Commonly, differences can be found not just among species, but also within species (between sexes). Being ectotherms, insects life is seriously affected by ambient temperature, but their survival is even more seriously affected by humans. Habitat alteration (degradation) is considered one of the main causes of insect decline and local extinctions. Therefore, it is meaningful to pay attention to habitats heavy influenced by human activities (e.g., agricultural landscapes, urban environments or post-mining sites), where efficient measures to support insect biodiversity can be developed. In this talk, we will introduce you diverse research (published as well as the freshest pieces) and conservation measures that the Insect Ecology Group conducted to disentangle the mystery of insect lives and support insect biodiversity in Central Europe.

Active tools to protect wild fauna and flora species from extinction

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The question how to save some most threatened species from extinction is not easy to answer. Sometimes the legal protection made by passive prohibitions arising from the Act No. 114/1992 Coll. on the nature conservation and landscape protection is not enough. State nature conservancy authorities therofe implement so called species action plans. These are long-term strategic documents which have a simple goal – to save the species by active approach, specific measures which are made according to the needs of the specific threatened and most endangered species of wild fauna and flora. Species action plans are realised under supervising authority – the Ministry of Environment and the Nature Conservation Agency of the Czech Republic. The candidate species must fulfil specific conditions – native species, specially protected according the law, endangered by threats that are reachable and implementable, economically viable in a long term period. The criteria for species selection and modus operandi for species action plans elaboration and implementation is described in the Concept for Active Species Protection Tools in the Czech Republic 2023-2032. Among main groups of proposed maeasures belong management of the species habitat, cooperation with land owners or tenants, ex situ management (breeding in captivity, cultivation) and reintroduction into the habitat that is prepared and fulfils the species biological needs. We have to be sure that the reintroduction is sustainable and that the threats are mitigated by active approach and measures. An integral part of each species action plan is the research, monitoring of the species and monitoring of realised management. All the management has to be based on best practise, best knowledge, best data as each specimen of the species has usually enormous value for the remaining population. To explain the steps that are taken for protection of the species to the stakeholders it is also necessary to think of the public awareness and education. So far 7 species action plans for animal species (e.g. Scarce Fritillary, Freshwater Pearl Mussel,

European Ground Squirrel, Little Owl), and 7 species action plans for plants (e.g. Eastern Pasque Flower, Bohemian Sand Pink, Bohemian Early Gentian, Lilyleaf Ladybells) are implemented.

As the species action plans can be prepared for specially protected species according to the Act No. 114/1992 only, for the species that are threatened on a regional level and listed as endangered by the IUCN Red List (national), the Nature Conservation Agency runs regional action plans. In fact, reagional action plans are small-scale species action plans and 13 of them are having been realised (e.g. Capercaillie in the Protected Landscape Area the Beskydy Mountains).

There are also animal species that are endangered and cause different human-wildlife conflict by their natural way of beeing. They are e.g. Wolf, European Beaver or Eurasian Otter. For those species management plans are implemented as a special strategic documents with the goal to mitigate the conflict potential. Within these plans the state nature conservancy tries to support the stakeholders by different subsidies and seeks understanding and better acceptance of the species occurence within the country. These species are not bread in captivity; they are not reintroduced as they do not need such a kind of intervention. On the other hand, they are very often subject of illegal killing and other threats and therefore they deserve some kind of active approach at the national prospective.

For more information on active species protection tools in the Czech Republic see www.zachranneprogramy.cz/en/.

Species action plans, regional action plans and species management plans are three types of active species protection tools that are subject of national species protection approach. We believe that our goal to save the most threatened and endangered species will come true, even if the there are many obstacles (climate change, negative attitude of stakeholders, ways of using agriculture land,…). Our efforts have been reflected in the Prospective LIFE (Protect Species Actively by LIFE) project that the Nature Conservation Agency runs together with the Ministry of Environment since January 2024 and will take 10 years (https://www.nature.cz/life-prospective).

The Urban Fearscape: Lessons from Bird Flight Responses in Urban Habitats

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Urbanization is often regarded as a major threat to global biodiversity, but the reality is more nuanced. While certain species completely avoid urban areas, many others manage to invade, establish, and even thrive in cities. A critical factor enabling successful coexistence between wildlife and humans is the degree of animal tolerance toward human presence. As human populations continue to grow, interactions between wildlife and humans will become more frequent, making it crucial to understand the drivers and mechanisms that shape animal tolerance. This knowledge can guide conservation efforts, such as creating buffer zones to minimize human disturbances or designing cities that are more accommodating to wildlife. However, research has shown that tolerance levels in urban animals are highly context-specific. Moreover, we still lack a comprehensive understanding of the variations in animal tolerance—across individuals, populations, and species—over time and space, as well as the underlying mechanisms. To advance this field, future efforts should focus on: (1) developing stronger predictive models and theories; (2) investigating global patterns in animal tolerance, considering taxa with diverse evolutionary histories, biogeographies, life strategies, and habitats; (3) studying individually marked and repeatedly observed animals; and (4) creating tools to support conservation and management decisions.

Keywords: birds, escape distance, flight initiation distance, landscape of fear, urbanization

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