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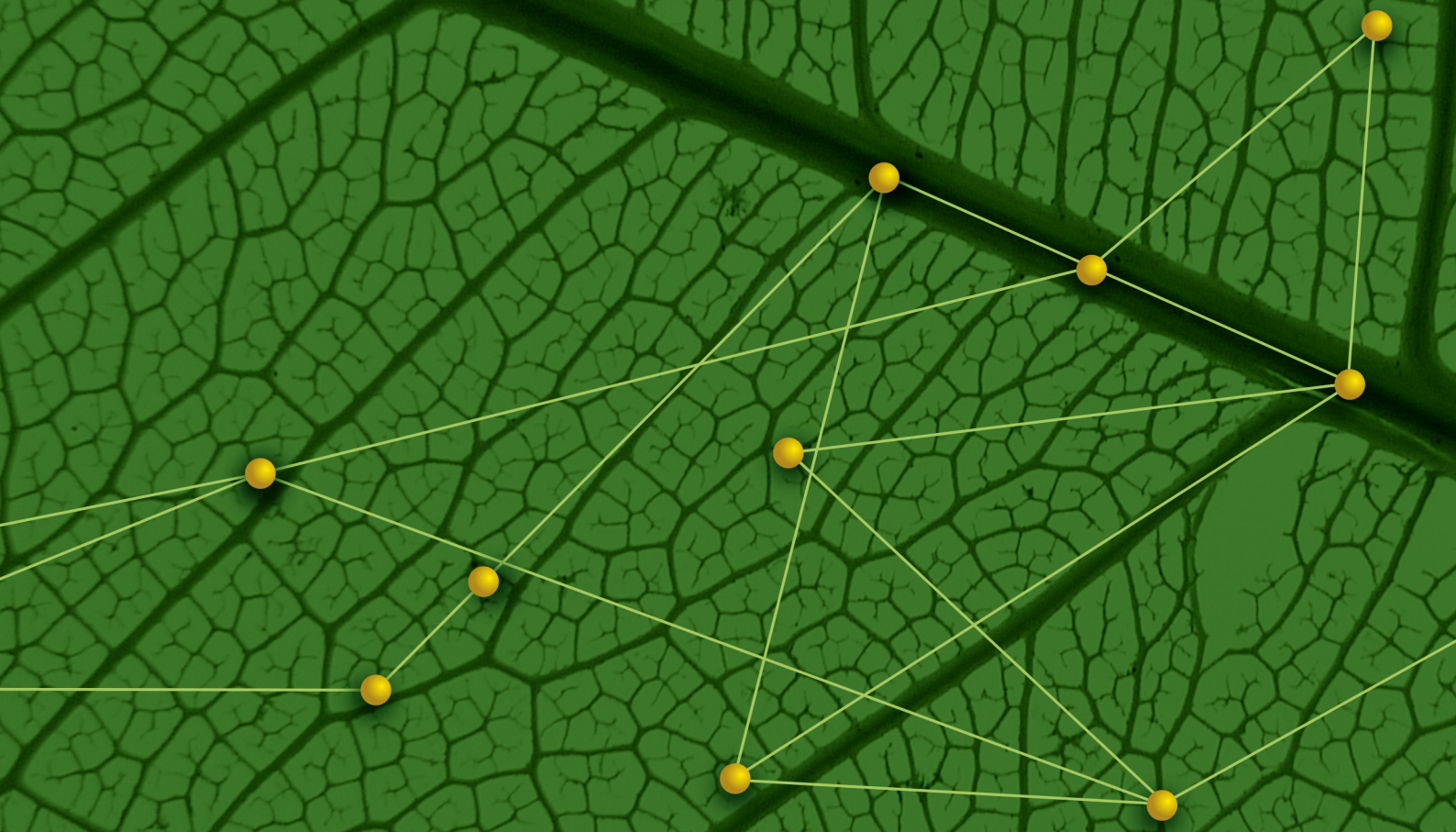
TRENTINO

2026 EUBIRECO

Euregio Biodiversity Research Conference
Tyrol - South Tyrol - Trentino
5-6 November 2026

MUSE - Science Museum, Trento, Italy

Book of Abstracts



BOOK OF ABSTRACTS

EuBiReCo
Euregio Biodiversity Conference 2026

MUSE – Science Museum of Trento, 5th-6th November 2026

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KEYNOTES

KEYNOTE 1 - Life at altitude: mountain ecosystems through a remote-sensing lens

David Coomes[1]

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Airborne lidar and geospatial Earth observation foundation models are transforming how we study the effects of land management and climate change on natural habitats. In this talk, I will present ongoing work to map ground vegetation across Scotland, focusing on the distribution of heather (Calluna vulgaris) and its responses to deer management, fire and a changing climate. I will also explore how monitoring heather height can provide an indicator of fire risk. Together, these examples illustrate how remote-sensing approaches developed largely for forests are opening new opportunities to understand and monitor more extreme environments, including upland heathlands and alpine vegetation.

Keywords: Airborne LiDAR, Remote Sensing, Calluna vulgaris, Land management

KEYNOTE 2 - Disentangling the relationships among vertebrate and mosquito diversity and emerging mosquito-borne diseases

David Roiz[1]

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Understanding how biodiversity shapes the transmission of mosquito-borne pathogens is essential for predicting and preventing emerging zoonotic diseases. The dilution effect occurs when greater biodiversity reduces pathogen transmission. However, these relationships depend not only on species richness, but also on community composition, ecological interactions, and the environmental context in which transmission occurs. We investigated how vertebrate and mosquito communities, landscape structure, and human-driven environmental change influence the transmission dynamics of mosquito-borne viruses, including West Nile virus and Usutu virus. Fieldwork was conducted using a standardized experimental design across wetland and urban-to-natural gradients in the Camargue (France), the Yucatán Peninsula (Mexico), and Hamburg (Germany). We analyzed mosquito abundance, blood-feeding patterns, and infection rates to assess how these variables relate to host diversity, land use, and climatic conditions. We also developed the Community Competence Index (CCI), an integrative metric designed to characterize the potential of ecological communities to support pathogen amplification and transmission in relation to their species composition and interactions. Our findings reveal how vertebrate and mosquito diversity, landscape transformation, and host-feeding preferences jointly shape vector–host–pathogen interactions and influence arbovirus transmission risk. By moving beyond species richness towards a community-level perspective, this approach provides a framework for understanding the ecological mechanisms underlying disease emergence and improving surveillance and risk assessment under ongoing environmental change.

Keywords: Biodiversity–disease relationships, Dilution effect, Mosquito-borne viruses, Community ecology, Community Competence Index, Land use

KEYNOTE 3 - Biodiversity meets human diversity. Understanding people for effective conservation

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Biodiversity conservation is not only about understanding the diversity of life at the genetic, species and ecosystem levels, but also about understanding people. People differ in their values, emotions, knowledge, interests and relationships with nature, which influences how they perceive biodiversity, engage in conservation and respond to conservation measures. Yet, how is this human diversity considered in biodiversity conservation research and practice? In this talk, I will draw on citizen science research from Berlin, explore underlying drivers for the acceptance of conservation measures and lastly, reflect on how meaningful interactions with nature and wildlife might shape human-nature-wildlife relationships. Ultimately, effective biodiversity conservation requires us to look beyond biodiversity itself and recognise the diversity of people, their sometimes ambivalent relationships with nature and how we can support these relationships in a rapidly changing world.

KEYNOTE 4 - The effects of glacier retreat on biodiversity

Gentile Francesco Ficetola[1]

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The global retreat of glaciers is one of the most evident consequences of climate change. What are the consequences of glacier retreat for terrestrial ecosystems? How do animals, plants, and microorganisms colonize these environments, transforming seemingly lifeless areas into complex ecosystems? To answer these questions, we analyzed soil features and environmental DNA (eDNA) from multiple areas across the globe—including the Alps, Central Asia, the Andes, North and South America, and the Arctic—where glaciers have retreated in recent decades, and studied the biodiversity of all the major taxonomic groups: bacteria, fungi, plants, protists, and soil animals. We found that all the environmental properties quickly change with time since glaciers retreated, and that temperature modulates the accumulation of soil nutrients. The diversity of bacteria, fungi, plants and animals increases with time since deglaciation, but their temporal patterns differ. Microorganisms colonized most rapidly in the first decades after glacier retreat, whereas most macroorganisms took longer. Increased habitat suitability, growing complexity of biotic interactions and temporal colonization all contribute to the increase in biodiversity over time. These processes also modify community composition for all the groups of organisms. Plant communities show positive links with all other biodiversity components and have a key role in ecosystem development. These unifying patterns provide new insights into the early dynamics of deglaciated terrains and highlight the need for integrated surveillance of their multiple environmental properties.

Keywords: Glacier retreat, eDNA, multi-taxa approach, terrestrial ecosystems.

SESSION 1

New tools for biodiversity assessment and Big Data management

Session 1 - New tools for biodiversity assessment and Big Data management

This session showcases the transition from descriptive field biology to automated, real-time ecosystem intelligence. By integrating advanced monitoring tools—including remote sensing, robotics, eDNA, isotopes, bioacustics, and camera trapping— this session enables an unprecedented overview of high-resolution data collection. Furthermore, we will address the challenges of the "Big Data" era, focusing on the application of Artificial Intelligence in ecological modelling and the implementation of FAIR data principles (Findable, Accessible, Interoperable, Reusable) in collaborative projects.

ORAL PRESENTATIONS

OP 1.1 - From diet to microbiome: High-resolution metagenomic profiling in Alpine wildlife

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Accurate dietary characterization is fundamental to understanding wildlife resilience in sensitive Alpine ecosystems. While DNA metabarcoding of non-invasive fecal samples is widely used, it often lacks the resolution to distinguish closely related plant species. We evaluated a high-precision framework using shotgun metagenomics of fecal pellets to achieve species-level dietary resolution while simultaneously profiling the host microbiome.

Our approach was validated using the Alpine rock ptarmigan (*Lagopus muta helvetica*), a cold-adapted glacial relict in the Italian Alps. We evaluated shotgun sequencing with the Kraken2 classifier against curated reference databases enhanced with the latest NCBI-GenBank sequences.

Our findings demonstrated that a single fecal sample can simultaneously characterize detailed dietary composition and its influence on gut microbial species. We identified links between specific medicinal plants in ptarmigan diets and reduced pathogenic gut bacteria, suggesting a direct mechanism for modulating animal health. Furthermore, the detection of both soil-health indicators and plant pathogens in the ptarmigan gut demonstrates that shotgun sequencing can also inform on habitat-level integrity. This innovative approach offers a scalable tool for the conservation of Alpine species and their habitats, including the Alpine chamois (*Rupicapra rupicapra rupicapra*) and mountain hare (*Lepus timidus*).

Keywords: Shotgun metagenomics, Alpine rock ptarmigan, Dietary characterization, Gut microbiome

OP 1.2 - Beyond independent observers: Graph-based modeling of fine-grained biodiversity occupancy dynamics in acoustic networks.

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Biodiversity monitoring at scale increasingly relies on automated sensors, yet standard workflows treat devices as isolated observers, conflating true species absence with imperfect detection.
This bias is severe across steep elevational gradients where terrain, vegetation, and weather alter acoustic detection conditions. To resolve this, we developed a network-fused hierarchical framework modeling species occupancy at a high temporal resolution (4-hour bins) to capture fine-grained diurnal and intra-seasonal dynamics. Using data from 63 acoustic sensors tracking 71 bird species across an elevational gradient in South-Tyrol, each automated detection is modeled as an imperfect observation of a latent occupancy state. Information propagates across sites via a heterogeneous network encoding geographic proximity, shared elevational belts, and habitat classes. This graph processes weather covariates to estimate short-term occurrence probability as a Bayesian posterior of BirdNET detection probabilities.

Tested on breeding-season data, the framework recovered 16% more true presences than raw BirdNET outputs and outperformed MaxEnt and Random Forest models (AUC-ROC: 0.873 vs. 0.847).
Ablation experiments confirmed that explicitly factoring imperfect detection drove this performance, while the network structure provided significant additional gains. Moreover, the framework is sensor-, classifier-, and taxa-agnostic and provides a principled, scalable foundation for dense monitoring networks.

Keywords: Occupancy modeling, Acoustic monitoring, Elevational gradient, Graph neural network, Imperfect detection

OP 1.3 - Forest tree species mapping in Trentino with Sentinel-2 and PlanetScope remotely sensed data

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Mapping tree species composition is a prerequisite for evaluating forest biodiversity, supporting habitat conservation, and monitoring ecosystem resilience. While high-resolution UAV or airborne platforms excel at local scales, broad-scale biodiversity monitoring across taxonomically diverse forests using satellite imagery remains challenging due to mixed species presence and heterogeneous phenology in areas with complex topography. This research evaluates the integration of multitemporal satellite PlanetScope and Sentinel-2 datasets with localized climatic covariates to map tree species diversity across the Autonomous Province of Trento (Italy).

Cloud-free monthly image composites from June to October 2021 were coupled with climatic variables to capture both phenological dynamics and environmental niches. Reference inventory data reflecting species distribution were gathered from forest management plans at the stand/polygon level. To handle species heterogeneity within these units, we implemented two methodologies: data clustering and hierarchical data augmentation. Crucially, the classification framework leveraged cutting-edge supervised learning by incorporating geospatial foundation model embeddings, specifically evaluating Google AlphaEarth and Tessera, to extract highly representative features from the remote sensing imagery.

The findings demonstrate that integrating climatic variables alongside satellite data enhances species discrimination. Furthermore, embeddings from AlphaEarth and Tessera helped the characterization of complex biodiversity patterns compared to standard spectral features.
Finally, PlanetScope's finer spatial resolution proved essential for differentiating a broader range of species. These results underscore the potential of data fusion to deliver robust, large-scale biodiversity indicators for forest ecosystems.

Keywords: Tree species, Remote sensing, Satellite images

OP 1.4 - Dolichens: An information system on the lichens of the Dolomites

Nascimbene J. [1], Francesconi L. [1], Conti M. [1], Di Musciano M. [2], Di Nuzzo L. [1], Gheza G. [1], Martellos S. [3], Mayrhofer H. [4], Nimis P. L. [3], Pistocchi C. [1], Gruber M. [4]

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Lichens, despite their key role as environmental indicators and their ecological importance, remain underrepresented in conservation policies, largely due to fragmented exploration of several areas, as well as limited availability of data in digital platforms. The Dolomites are one of the lichenologically best-known areas in Italy, with a long history of exploration since the 19th century. However, the relevant amount of data produced by these efforts was scattered and often not accessible in digital format, thus hindering data accessibility and usability. To address this gap, the Dolichens project was launched in 2022, by aggregating over 85,000 occurrences spanning from 1820 to 2026 for 2100 infrageneric taxa into an accessible online web platform, designed to ensure data interoperability with the most relevant global repositories.
In addition to data mobilization, targeted field surveys related to the Dolichens project have substantially improved the coverage of previously underexplored areas, leading to the discovery of species new to Italy and to science, as well as the publication of lichen checklists for several protected areas.
This inventory provides a comprehensive resource for tracking lichen diversity in the Dolomites over two centuries and sets a basis for forthcoming taxonomic, biogeographical, and ecological studies.

Keywords: Dolichens, Dolomites, Information system, Lichens

OP 1.5 - Testing novel technologies for scalable biodiversity monitoring: insights from Biodiversa+ pilots in South Tyrol

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Robust biodiversity monitoring is essential to detect ecological change and support conservation decisions, yet many monitoring schemes remain difficult to scale due to the high level of effort required for sampling, the specialist expertise needed, and the need for repeated field surveys. Within the Biodiversa+ Partnership, a portfolio of pilot studies is testing whether novel, cost-efficient and easier-to-implement approaches can strengthen biodiversity monitoring across taxa, habitats and countries.

This contribution provides an overview of the Biodiversa+ monitoring pilots to which South Tyrol contributes, addressing different biodiversity components, including soil biodiversity, light-attracted insects, bats, birds, invasive alien species, grassland habitats and forest-related biodiversity monitoring. Emphasis will be placed on the implications and challenges of the tested novel technologies, including automated biodiversity monitoring stations, remote sensing, eDNA, bioacoustic monitoring and AI-supported species identification. Drawing on activities implemented in the Province of Bolzano/South Tyrol, we present selected results from the comparison between eDNA-based soil biodiversity assessment and traditional identification methods, as well as from automated camera-image identification, highlighting the role of continuously improving AI models. Overall, the Biodiversa+ pilots provide an opportunity to test novel methods across countries and build capacity for the future of biodiversity monitoring.

Keywords: European biodiversity, Automated monitoring, Harmonized protocols

OP 1.6 - Biodiversity and data challenges: from local collection to global perspectives

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Technology has immensely spurred the collection of biodiversity data across habitats and levels of organisation. Among many, animal-borne sensors and distributed environmental sensors have increased our knowledge on the distribution, behaviour, functions and relations of vertebrate species. Individual bio-logging captures unique animal behaviours and physiological responses, whereas environmental sensors like camera traps and acoustic recorders monitor broader ecosystems. These tools produce a wealth of 'big data' of high ecological value, yet how to best process, preserve and integrate such data streams is still an unresolved challenge. The global perspective offers a unique opportunity to set up pipelines to transform technology-derived data into biodiversity indicators to measure the status and trends of Essential Biodiversity Values, so supporting environmental policies at different levels. This critical integration challenge includes FAIR data management pathways, advanced analytical frameworks, new opportunities offered by multi-modal AI. Ultimately, combining these distinct sensing technologies is both necessary and achievable for future biodiversity preservation.

Keywords: Bio-logging, Camera trapping, GeoBON, Indicators, EBVs

OP 1.7 - Towards a quantitative criterion for Italian Alpine bird migration corridors

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Italian Alpine migratory corridors currently recognized by law as key routes for bird migration have been identified mainly based on historical information and qualitative assessments. However, the lack of a quantitative criterion makes it difficult to objectively verify their actual function as migration corridors. In this study, we evaluated whether the intensity and direction of migratory bird traffic can serve as operational parameters to distinguish recognized corridors from other sites with similar geographical features without legal protection. Firstly, we ranked alpine passes as suitable for migration based on their location, elevation,

orientation and other geographical characteristics. Then, we analyzed vertical-looking radar data collected in 2024–2025 at 33 Italian Alpine sites, including legally recognized corridors, corridors proposed for verification, and non-corridor sites. Parallel bioacoustic surveys were used to describe vocal activity and complement the interpretation of movement patterns.

The Migration Traffic Rate (MTR), derived from radar data, was used as a quantitative indicator of movement intensity, and flight direction was considered to separate coherent migratory traffic from local movements and refine site classification. Comparisons of MTR distributions and flight directions among site categories revealed systematic differences in crossing patterns, suggesting that these parameters may reflect corridor function. Based on these results, we identified a preliminary quantitative threshold potentially useful to distinguish sites serving as functional migratory corridors. This approach provides an empirical basis for defining Italian Alpine migratory corridors operationally, supporting more consistent classifications and guiding the planning and management of migration monitoring activities.

Keywords: Bird migration, Alps, Radar, Acoustic monitoring

OP 1.8 - Passive acoustic monitoring and dynamic occupancy models for tracking within-season distribution dynamic of breeding birds in South Tyrol: A framework for Euregio Biodiversity Monitoring.

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Within-season movements are often overlooked when studying breeding bird distribution and habitat use despite their importance for effective conservation. Habitat suitability can vary over short periods of time, inducing individuals to move within the same breeding season. Mountain regions provide ideal conditions for studying these dynamics as they are characterized by steep environmental gradients over short distances.

In this study, we investigated within-season changes in breeding bird distribution in South Tyrol by combining passive acoustic monitoring, automatic species recognition software and occupancy models. We placed recorders across different habitats and elevations, and we analyzed the collected data by using BirdNET analyzer and applying species-specific confidence thresholds. We selected 46 bird species with reliable detections and compared static and dynamic occupancy models. Dynamic occupancy models generally outperformed static occupancy models and detailed analysis of six species showed varying occupancy dynamics. Initial occupancy probability was always positively associated with suitable habitat cover while occupancy shifts showed more complex patterns. Elevation was not consistently relevant for occupancy dynamics, although some species showed indirect effects linked to environmental variations. Overall, our results show that bird distributions can change within the breeding season, underlining the need for further research on these dynamics and their drivers.

Keywords: Spatial ecology, Birds, Bioacoustics, Mountain ecosystems, Occupancy models

OP 1.9 - Air biodiversity and environmental DNA: a curated pipeline for enhancing taxonomic resolution

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Environmental DNA (eDNA) metabarcoding offers a powerful alternative for aerobiome identification, though its standardization remains challenging. This study characterizes air biodiversity in a rural Alpine site using gravimetric sampling, focusing on optimizing methodological workflows—including DNA amplification, target barcode selection, and bioinformatics pipelines—while comparing global versus curated local reference databases.

Weekly specimens were analyzed in parallel via conventional optical microscopy and DNA metabarcoding, testing various barcode and amplification combinations. Results indicate that the ITS2 selected primers, combined with KAPA polymerase, provided superior taxonomic resolution, identifying 76 plant species compared to 28 with ITS1. Furthermore, the Allpoll custom, and GBIF reference databases (89 and 96 identified plant species) outperformed global databases like UNITE, BOLD and PLANiTS (67, 67 and 61 species, respectively), effectively correcting common misidentifications. While microscopy detected 41 taxa, eDNA resolved more than 120 taxa at various taxonomical levels with the only ITS2 barcode, including species-level Poaceae.

Ultimately, this study confirms the effectiveness of gravimetric sampling for high-depth aerobiome monitoring. By implementing optimized pipelines and curated databases, researchers can achieve a more precise and comprehensive assessment of environmental biodiversity, addressing critical gaps in current aerobiological monitoring frameworks.

Keywords: eDNA metabarcoding, NGS, Aerobiological passive sampling, Light microscopy, Alpine biogeographical region

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OP 1.10 - Airborne pollen as a proxy for alpine plant biodiversity: a combined optical microscopy and environmental DNA metabarcoding approach

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Alpine ecosystems face severe threats from global change, necessitating robust monitoring to track shifts in plant communities. Airborne pollen serves as a valuable proxy for modern plant biodiversity. As part of the NBFC-Bioalpec initiative, the ALPoll project investigated pollen-vegetation relationships across four protected Alpine sites in Trentino, Italy (1906–2608 m a.s.l.).Aerobiological samples collected with Sigma-2 gravimetric samplers were analyzed using optical microscopy (OM) and environmental DNA (eDNA) metabarcoding, then compared with vegetation surveys within 10, 100, and 1000 m from the sampler.

OM identified 53 pollen taxa, capturing down-slope inputs of thermophilous woody taxa alongside local flora. Pollen-vegetation Jaccard similarity was low to moderate, ranging from 0.19 (10 m) to 0.26 (1000 m), suggesting that pollen spectra reflect regional landscape heterogeneity over strictly local vegetation. Crucially, aerobiological monitoring captured phenophases, including a temporal delay in the Poaceae peak flowering with increasing elevations. Furthermore, a pilot eDNA analysis of Poaceae input —undifferentiated by OM—drastically enhanced taxonomic resolution, revealing over 20 distinct species.

The combination of OM and eDNA in pollen identification maximizes taxonomic resolution, potentially capturing threatened or alien species. Pollen monitoring can, thus, provide vital data in support of targeted conservation and management strategies.

Keywords: Alpine ecosystems, Airborne pollen, eDNA metabarcoding, Pollen-vegetation relationships, Optical microscopy

OP 1.11 - Project CATS: monitoring in real-time aerobiological biodiversity in Trentino - Südtirol

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Recent technological advances have enabled automatic pollen monitoring, complementing traditional Hirst-type samplers and expanding monitoring capabilities. Instruments such as the Poleno Mars provide real-time, high-resolution data by applying flow cytometry to capture holographic images of airborne particles. These images are processed using machine learning algorithms to classify pollen taxa.

In Trentino-Alto Adige, two automatic samplers were installed by the Agency for Environment and Climate Protection (Bozen) and the Research and Innovation Centre of the Edmund Mach Foundation (San Michele all'Adige). A collaboration was established within the CATS project (Classification Adaptation Trentino-Südtirol), launched in April 2023, aimed at adapting a Swiss-developed model to the biodiversity of the regional flora. Local pollen samples were collected from at least three plants per species and measured parallel by the two automatic instruments to generate a minimum of 5,000 holographic images per taxon. Curated new datasets and historical pollen monitoring data were then used to refine the algorithm, in cooperation with the manufacturer.

The improved model, identifying 12 pollen taxa, is currently in a testing phase. Ongoing work focuses on increasing the number of recognized pollen taxa and making real-time data publicly accessible to provide timely and relevant information for citizens.

Keywords: Automatic pollen monitoring, Real-time data, Flow cytometry, Machine learning, CATS project

OP 1.12 - Diversity of microbial eukaryotes in Alpine proglacial lakes (Cevedale glacier, Italy)

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Proglacial lakes are forming at increased rates in the Alpine high mountain environment, yet their ecological evolution remains only partially known. We studied the microbial eukaryotic communities in four proglacial lakes and one clear-water lake in the Ortles-Cevedale Massif (Italian Alps, 2700-2900 m asl), representing a deglaciation chronosequence. During the ice-free seasons 2022-2023, we collected eDNA from the water column and littoral areas (epilithic biofilms) and water samples for chemistry analyses. We targeted the 18S rRNA region to detect microbial eukaryotic biodiversity.

Diversity was higher in epilithic than in planktonic samples, highlighting the prominent role of littoral benthos in shaping proglacial lake ecosystems. Amplicon Sequence Variants (ASV) richness had different spatial patterns: ASV richness did not differ significantly between lakes for plankton, whereas it significantly differed in epilithic samples. Furthermore, planktonic ASV richness was not significantly correlated with any environmental variable, while epilithic richness was positively correlated with silica concentrations and water temperature, and negatively correlated with turbidity. These findings support the hypothesis that stochastic processes, such as dispersion, are the primary drivers of the planktonic assemblages of the studied lakes. Conversely, the littoral benthos appeared more responsive to the environmental evolution linked to the loss of glacial influence.

Keywords: Proglacial lakes, 18S, Deglaciation

OP 1.13 - Improving population estimates of the Western capercaillie (*Tetrao urogallus*) at the edge of its range: integrating non-invasive genetics and spatial capture-recapture models

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Accurate estimates of population size are essential for wildlife conservation, particularly for elusive species living in rapidly changing Alpine ecosystems. The Western capercaillie is declining across the southern edge of its range, where habitat fragmentation, climate change, and human disturbance threaten persistence and connectivity. Traditional monitoring based on lek counts primarily targets displaying adult males and typically underestimates population size. To overcome this limitation, we developed a standardized framework combining systematic non-invasive genetic monitoring with spatial capture-recapture modeling.

We sampled 92 lekking sites in the Central Eastern Italian Alps and collected more than 1300 non-invasive samples. Using individual genotyping, we identified 213 individuals (145 males, 68 females). Including sex as a factor influencing detection probability and movement rate, we estimated variation in population density in response to environmental covariates, obtaining a mean density of 0.15 individuals/hectare and an abundance of 334 individuals. Females were less detectable than males, but the estimated sex ratio was balanced. Density decreased with distance from the lek center and increased with elevation, northness, and ridge-like terrain features. This framework provides a robust and transferable approach for monitoring capercaillie population dynamics or that of other elusive vertebrates.

Keywords: Forest grouse, Lek detection, Fecal DNA, SCR models, Wildlife monitoring

OP 1.14 - Mapping the Landscape of Fear in forest rodents using integrated automated monitoring and behavioural experiments.

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In alpine ecosystems rodents constitute a key trophic resource for predators, and the trade-off between foraging and avoiding predation shapes their behaviour. The Landscape of Fear framework describes animals' perception and response to variation in predation risk, while individual personality may further mediate risk perception and foraging decisions. However, personality's influence on these processes remains unexplored, particularly in habitats lacking refuges, such as coppice forests. Moreover, whether rodents mitigate predation risk by adjusting activity periods to reduce overlap with predators remains unclear.

Through a study conducted in the Val Alba Nature Reserve, we integrated multiple approaches to assess the Landscape of Fear in two rodent species. We combined passive bioacoustic monitoring and playback to detect avian predators, camera trapping to assess mammalian carnivore presence, and capture–mark–recapture methods coupled with three behavioural tests to quantify personality traits in *Apodemus flavicollis* and *Clethrionomys glareolus*. We analysed microhabitat structure at trapping points, as rodents' risk perception relies on local habitat features, and quantified rodents' activity and foraging-site selection through cafeteria-style experiments monitored via infrared cameras and RFID readers.

Our results demonstrate that combining automated monitoring technologies with behavioural experiments enables high-resolution characterisation of the Landscape of Fear in alpine forest ecosystems.

Keywords: Landscape of Fear, Camera Trapping, Bioacoustic, Rodents behaviour

SPEED TALKS

ST 1.1 - First record of the invasive Asian clam *Corbicula fluminea* (Müller, 1774) in South Tyrol: may small watercraft be the pathway for its introduction into a natural lake?

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We report the first record of the Asian clam *Corbicula fluminea* (Müller, 1774) (Mollusca: Bivalvia) in South Tyrol in the Large Lake Monticolo in the summer of 2025. Asian clams were found only in a small area of the lake in front of a bath establishment at depths ranging from 1 to 6.6 meters.
The histogram of frequency distribution in 0.5 mm size classes shows a well-structured population, consisting of at least two generations. The hypothetical introduction into the lake may be dated to the spring or early summer of 2023. The quantitative survey conducted by diver on live clams revealed mean density of 84 ± 16 ind. m-2 at a depth of 2.0 m and 446 ± 25 ind. m-2 at a depth of 4.0 m. We discussed the potential role of small watercraft (stand-up paddleboards and canoes) as a pathway for passive transport of larval stages into the lake.

Keywords: Invasive species, *Corbicula fluminea*, Stand-up paddleboards, Passive transport, Larval stages

ST 1.2 - An AI-integrated thermal camera system to prevent wildlife-vehicle collisions: a tool for ecological data acquisition

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Wildlife-vehicle collisions (WVCs) cause serious problems for both people and animals involved.
AI-equipped technical solutions are emerging to warn drivers of the presence of animals on the road, as traditional methods of preventing WVCs are often ineffective. In the Autonomous Province of Trento, we evaluated an AI-integrated thermal camera pilot project by matching camera traps for animal species-specific identification. Unmanaged hardware malfunctions and GDPR privacy restrictions significantly limited data collection for the AI-integrated thermal camera system. However, this technology has shown to be a valuable source of ecological information in addition to its value in collision prevention.

Keywords: Wildlife-vehicle collisions, Thermal camera, Camera trap, Road network, Artificial intelligence

ST 1.3 - High-resolution molecular monitoring reveals hidden freshwater gastrotrich diversity

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Freshwater gastrotrichs are microscopic metazoans whose diversity remains poorly documented. We tested a high-resolution DNA metabarcoding workflow across 12 Italian freshwater biotopes. Sediment cores were processed through Ludox separation, filtration, DNA extraction, and Illumina MiSeq sequencing targeting 18S V4 and Folmer COI mini-barcodes. Bioinformatic analyses in QIIME2 generated ASVs that were assigned using marker-specific taxonomic approaches. Gastrotrich DNA was detected in all sampled biotopes, including five sites negative by morphology and one dry pond. Curated reference databases substantially improved taxonomic resolution, demonstrating the potential of scalable molecular monitoring for freshwater meiofaunal biodiversity assessment.

Keywords: Gastrotricha, Freshwater meiofauna, DNA metabarcoding, Biodiversity assessment, Reference databases

ST 1.4 - Cultural Ecosystem Services reflect alpine landscape diversity along altitudinal patterns: a social media imagery analysis

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Cultural Ecosystem Services (CES) are essential for human well-being, particularly in alpine areas where demand for nature-based experiences is increasing. However, their assessment remains challenging due to their intangible nature. This study uses georeferenced photographs from Flickr (2013–2025) to assess CES across the Noce, Sarca and Brenta river basins (Trento Province, Italy). A ResNet-152 deep learning model was developed to classify CES-related images, while the Threshold Indicator Taxa Analysis (TITAN) was applied to investigate CES responses along an altitudinal gradient. Results highlight how cultural benefits vary with environmental and landscape diversity across mountain ecosystems.

Keywords: Alpine ecosystem, Cultural Ecosystem Services, Human-nature interactions, Social media, User-generated content

ST 1.5 - How passive acoustic and traditional monitoring estimate bird diversity across habitats

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Bird monitoring schemes have evolved substantially and new technologies such as passive acoustic monitoring (PAM) are becoming increasingly popular. As more monitoring schemes adopt PAM, it is crucial to understand how comparable it is with classical monitoring derived data.
We compared diversity indices (i.e. species richness, Shannon diversity and Jaccard index) derived from both classical (observer-based point counts) and passive acoustic monitoring (recording devices) and developed a novel estimated Shannon index based on PAM, using species-specific confidence thresholds and detection rates. We applied the protocols in a heterogeneous Alpine landscape to investigate for the first time whether the effectiveness of monitoring schemes depends on the habitat type.

We show that PAM captured twice as many species as the classical point count method.
The species richness by both protocols was strongly correlated (rs = 0.71), but with major differences between habitat types. The difference was greater in diversity hotspots such as wetlands and lower in alpine habitats. The novel PAM-based Shannon index was very reliable.

Although this study highlights the effectiveness of PAM, bird counts offer further insights (e.g., breeding status, acoustically indistinguishable species). Our results highlight the strengths and weaknesses of each approach and provide recommendations for future monitoring programs.

Keywords: Bird diversity, Habitat specificity, BirdNET, Passive acoustic monitoring

ST 1.6 - Can automated bird-sound classifiers replace expert observers? Evidence from the Biodiversity Monitoring South Tyrol

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Automated bird-sound classifiers (ABCs) are increasingly promoted as cost-effective tools for biodiversity surveys, particularly due to the limited availability of expert ornithologists and the substantial time and financial resources required for traditional survey methods. In this study, we evaluate the accuracy of an ABC in identifying bird vocalizations during standardized 10-minute point counts conducted within the Biodiversity Monitoring South Tyrol (BMS) framework.

Recordings were collected via the Merlin Bird ID smartphone application at more than 60 monitoring sites during point counts performed by expert ornithologists. To ensure independence between methods, the observer was not permitted to view the ABC output during surveys. Recording quality was optimized by minimizing noise from movement and conversation, positioning smartphones above ground level, and maintaining distance from other participants. Preliminary results indicate that the ABC detects fewer species than expert observers and produces both false-positive and false-negative identifications. Misclassifications appear to be associated with acoustically similar species, vocal mimicry, background noise (e.g., streams, traffic, or construction), and differences in smartphone microphone quality.
These findings suggest that current ABC technology is not sufficiently reliable as a stand-alone alternative to expert-based monitoring.

Keywords: Automated bird-sound classifier, Biodiversity Survey, Merlin Bird ID, Point counts

ST 1.7 - Ecological impacts and human-wildlife conflict of the expanding golden jackal (*Canis aureus*) in Friuli Venezia Giulia

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The recent expansion of carnivore populations across Europe has involved both apex and mesopredator species. However, the ecological impacts of newly colonising large mesopredators, such as the golden jackal (*Canis aureus*), remain poorly understood, particularly in alpine ecosystems where wolves are already established and involved in conflicts with human activities. Due to their high ecological plasticity, jackals are increasingly associated with people and native species, highlighting the need for robust population monitoring and better understanding of their trophic interactions. Camera trapping provides a cost-effective approach for surveying multiple species across large areas, while AI-based software simplifies data processing through automated species identification and site-specific measurements. These tools enable the evaluation of survey methods and density estimation models, helping to optimise wildlife monitoring.

Our three-year project uses camera traps and AI-based data-processing tools to monitor jackal expansion and interactions with other predators across alpine and lowland environments in north-eastern Italy. By analysing jackal density in relation to biotic and abiotic factors, we aim to predict niche partitioning with wolves and foxes, and expansion into novel areas. Integrating automated tools with wildlife monitoring approaches allows us to assess how survey methods and intensity influence species' detection probabilities across environments, improving efficiency while reducing costs.

Keywords: Mesopredators, Interactions, Camera-traps, Monitoring, Conflict

ST 1.8 - A harmonized genotyping approach for transboundary monitoring of wolves in the Alps: The ARGEALP experience

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Many terrestrial species have large ranges, with populations transcending geopolitical borders. Thus, monitoring programs that occur within national boundaries lack a full picture of population dynamics necessary for science-based management. Moreover, standard non-invasive genetic monitoring based on capillary electrophoresis of microsatellite markers requires the calibration of genotypes between laboratories, creating a barrier to rapid data exchange among national wildlife managers. The gray wolf (*Canis lupus*) is widespread across Europe and has a high dispersal capacity. Management of this species is of special interest for conservation purposes and to mediate human-wildlife conflict.

Recently, the Alpine Regions Working Community (ARGEALP) has moved towards the harmonization of transboundary genetic monitoring by implementing a new genotyping approach based on the high-throughput sequencing (HTS) of microsatellites from non-invasive samples. A key feature of this new approach is to provide access to the allele sequences, which allows for higher comparability between laboratories, while providing access to a new level of genetic diversity and evolutionary history information. In addition, because sequence data are analyzed with a single automated bioinformatic pipeline, the genotyping process can be performed simultaneously across large sample sizes, becomes very cost-effective, and is less dependent on subjective operator interpretation.

Keywords: Transboundary monitoring, High-throughput sequencing, Microsatellites, Harmonization

ST 1.9 - Decoding air biodiversity: project AirBiD bridges urban greenery and human well-being

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The AirBiD project (airbidproject.eu), funded by Biodiversa+ under the BiodivNBS 2023-2024 call, investigates how urban green elements shape the aerobiome (airborne bacteria, fungi, and pollen) to promote human health and design regenerative cities. The research focuses on five European cities: Trento, Vienna, Évora, Copenhagen, and Gothenburg. In each city, 25 passive samplers (Sigma-2) are arranged in a systematic grid across nine green space categories for a 12-month monitoring period. The aerobiome characterization combines optical microscopy for identifying and quantifying pollen and spores with advanced DNA analysis.

Following an optimized extraction protocol for low-biomass matrices, genomic DNA undergoes PCR amplification (targeting 16S rRNA and ITS regions) and Next-Generation Sequencing (NGS) to map airborne biodiversity. Integrating satellite data and Citizen Science, AirBiD will provide policymakers and urban planners with scientific tools to implement Nature-Based Solutions (NBS), maximizing ecosystem benefits while minimizing health risks for urban populations.

Keywords: Aerobiology, Passive sampling, eDNA, NBS, Well-being

ST 1.10 - High-sensitivity molecular characterization and biological role of unhatched parasitoid wasps in stink bug egg masses

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The brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae) is a highly polyphagous invasive species causing severe agricultural damage worldwide. To limit its spread, several countries, have implemented biological control programs based on release of the samurai wasp, *Trissolcus japonicus* (Hymenoptera: Scelionidae), the primary egg parasitoid of *H. halys* in its native range. These releases also occurred in South Tyrol between 2020 and 2023. Its introduction requires long-term monitoring to assess its effects on native and invasive stink bugs, and its competitive interactions with native parasitoids. However, such impacts may remain undetected because of the phenomenon known as “egg abortion” or an “evolutionary trap”, in which parasitoids fail to complete development in novel hosts lacking a shared co-evolutionary history, ultimately killing the host egg while leaving no evidence of parasitization.

Here, we present the development of a highly sensitive digital droplet PCR (ddPCR) assay to detect hidden parasitization events in unhatched stink bug egg masses. The assay includes species-specific primers and probes for eight native and non-native parasitoids and three common stink bug species. The results are expected to reveal previously unknown trophic relationships and provide a high-resolution monitoring tool for assessing non-target effects of a biological control program.

Keywords: Brown marmorated stink bug, Evolutionary trap, Digital droplet PCR assay, Host-parasitoid interactions, Stink bug egg masses

ST 1.11 - Can we estimate population trends from camera trapping data? Insights from multiple European long-term monitoring projects.

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Systematic camera trapping (CT) has become an established methodology to sample mammalian communities and monitor their changes through time. Yet, it is still unclear whether temporal trends from CT time-series data are reliable proxies of dynamic population parameters.
We compared trends from CT with hunting bags or capture-recapture data, taking advantage of two long-term datasets collected over 10 years in one study area in the Italian Alps and 3 study areas in Scandinavia. We found that the number of photographic sequences was a better proxy of population trends than occupancy, with a general agreement between CT and hunting bags trends.

Keywords: Wildlife monitoring, Population trends, Hunting bags, Population dynamics

ST 1.12 - Which tool now? A user-oriented perspective on AI tools for camera trap data

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Camera traps are one of the most relevant and widely used tools in wildlife ecology, that enable non-invasive collection of huge amounts of data across broad spatio-temporal scales and ecosystems. The extensive use of camera trapping has produced image volumes that far exceed the capacity of users to manually process them, posing substantial constraints to the research workflow. In recent years, several AI-based tools and platforms have been released to streamline data management by partially automating animal detection and classification tasks, thus potentially reducing processing time. However, the existing tools differ in design and intended use, and their suitability is strongly context-dependent. Choosing among them requires balancing model performance with practical trade-offs: from a user's perspective, aspects such as the type of input data supported, data sharing requirements, costs and ease of use of applications can be as influential as model reliability. Therefore, selecting the most appropriate tool can be a complex task for inexperienced users.

This work presents a potential workflow for choosing the most suitable AI-assisted tools for camera trap data management and classification. We aim to provide a pragmatic and user-oriented perspective, focusing on practical features, to help making informed decisions when integrating AI tools into camera trap–based studies.

Keywords: Camera traps, AI, Data management, User perspective

SESSION 2

Alpine biodiversity hotspots and extreme habitats

Session 2 - Alpine biodiversity hotspots and extreme habitats

This session focuses on life forms and the ecological complexities occurring in keystone extreme environments, interpreted in a broad sense (from glaciers to wetlands, from mountain ridges to subterranean caves). These localized habitats are defined by species richness and endemism, which provide disproportionately high contributions to global ecosystem functional processes. The focus will be on the occurrence and vulnerability of biodiversity hotspots to global change, emphasizing their role as early-warning systems for climate-driven changes.

ORAL PRESENTATIONS

OP 2.1 - Current and future threats of downhill skiing to Alpine birds

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Downhill skiing has been reported as potentially threatening mountain birds. Through a systematic review of papers assessing the direct/indirect impacts of infrastructures and pistes, we summarised known impacts, which are mostly based on studies carried out in the Alpine region, and on Galliformes. We then assessed the impact of ski piste on alpine birds' breeding habitat (at the territory scale). Water pipit shows a strong negative response, alpine accentor and, secondarily, northern wheatear a weaker avoidance, while snowfinch and black redstart were largely independent from piste location. We evaluated the spatial extent currently occupied by ski resorts and pistes along the Alps, modelled their future distributions and assessed the overlap with climate refugia (key sites for biodiversity conservation under a changing climate) in current and future conditions. Downhill ski-pistes occupy c. 500,00 ha and their distribution is predicted to shift upwards (from c. 1800 up to 2375 m), leading to a potentially larger overlap with climate refugia.
Given the impacts and the concerning future perspective, ski piste construction and management should be carefully governed to reduce negative outcomes on climate-threatened species and ecosystems.
We provide some practical guidelines based on alpine birds' breeding and foraging habitat selection.

Keywords: Mountain birds, Downhill skiing, Climate refugia, Distribution models

OP 2.2 - Quantifying the wind-borne arthropod flux on the Forni Glacier (Italian Alps) and its glacier foreland

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Mountain glaciers receive a continuous flow of wind-transported invertebrates, an allochthonous subsidy whose magnitude and direction remain poorly quantified. We measured the airborne arthropod flux over the Forni Glacier and its foreland (Italian Alps) using five vertical sticky panels, three on the glacier foreland (GF) and two on the eastern medial moraine (MM), over two summers (2023–2024). Thirty-two adhesive sheets (840 cm²; 22 on GF and 10 on MM) faced uphill and downhill. The traps collected 874 individuals across 8 orders and 33 families, averaging 27 ± 22 individuals per sheet; 140 (16%) were identified to species level (34 species). On the GF and the MM, there were no significant differences in the number of individuals on the downhill and uphill sheets. There were slight but opposite differences between the two years of sampling on the GF.

The most abundant species was the high-alpine fly *Phaonia chalinata* (28% of identified individuals), present in both settings; six foreland species also reached the glacier surface, which additionally intercepted two species absent from the foreland: the ballooning spider *Erigone tirolensis* and the valley fruit fly *Sphenella marginata*. Wind delivers a diverse arthropod subsidy whose dominant direction remains unresolved.

Keywords: Allochthonous subsidy, Aerial dispersal, Supraglacial ecosystem, Sticky traps, Alpine arthropods

OP 2.3 - Climate warming and alpine geomorphology interact to shape plant ranges

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Cold-adapted species living near mountaintops are considered particularly sensitive to climate change. Alpine geomorphology might accelerate climate-induced range contractions in Alpine plants due to geometric, substrate, and topographical constraints. The current distribution of plants inhabiting the highest elevations of the Alps is currently shaped by the interplay between temperature, geology, and topography. Due to the geomorphological constraints of mountain terrain, a future warming of 2°C will cause severe contractions of species ranges, with values reaching 75% for those with already more restricted distribution towards the peaks.

Calcareous peaks exhibited greater reductions than siliceous peaks, placing many endemic populations and species at risk of local extinction. Snow is one of the most important ecological drivers of alpine environments. Understanding its role in shaping the distribution of cold-adapted species is essential to complete the climatic and topographic framework used to assess their current and future ranges. To clarify the differences between siliceous and calcareous peaks, species ecological traits were analysed along the elevational gradient. These traits included dispersal capacity, plant height, growth form, and substrate specialization. The analyses revealed significant differences between the two geological settings, contributing to a more comprehensive explanation of species distribution beyond climate change effects.

Keywords: Alpine plants, Climate warming, Range contraction, Geomorphology, Snow cover

OP 2.4 - Comparative evolutionary history of six high-altitude plant species endemic to the Southeastern limestone Alps

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Biogeographers have long been interested in the uneven global distribution of endemic species. Beyond islands, mountain systems such as the European Alps are important hotspots of endemism. In the Eastern Alps the southeastern Limestone Alps (SELA) are particularly rich in endemic taxa. This richness has been linked to topographic heterogeneity, limited glaciation, and long-term climatic refugia in the past. Despite the importance of understanding this unique diversity — regarding how Alpine biota have evolved in general and also in regard of future conservation — spatiotemporal histories of Alpine narrow endemics remain poorly understood. In particular, the effects of recurring glacial barriers on lineage diversification and the distribution of intraspecific genetic variation are largely unknown.

To address these gaps, we studied 6 endemic plant taxa. Dense, range-wide sampling yielded genome-wide data from populations representing the entire range of these species. These data allow reconstruction of genetic variation over time and space, modelling of evolutionary and demographic processes, and identification of diversity patterns relevant for conservation.

Keywords: Endemic species, Evolution, Genomics, Pleistocene, Glaciation

OP 2.5 - No longer undercover – An isolation-based assessment of the diversity and distribution of Mortierellaceae from calcareous Alpine glacier forefields

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Mortierellaceae are a family of filamentous, predominantly saprotrophic fungi which contribute essentially to the core soil microbiome. Many members of Mortierellaceae can endure extremely disturbed, nutrient – depleted environments like glacier forefields. In these habitats, Mortierellaceae are a part of the pioneer microbial community, and it is proposed that they facilitate soil development. This study investigates the diversity and distribution of Mortierellaceae in four calcareous glacier forefields across the Alps (Griessen, Tsanfleuron, Marmolada, Dachstein). In total, 20 sediments from recently deglaciated areas (max. 25 years ice – free) were used for fungal isolation by direct plating. Isolated fungal pure cultures were identified based on phylogenetic analysis (rDNA – ITS region) and morphology.

A total of 16 species belonging to five Mortierellaceae genera were isolated. Additionally, strains belonging to two so far undescribed lineages could be isolated, which are prospects for novel genera. The genus *Mortierella* was the most abundant and occurred in all four glacier forefields. Some species seemed to be highly adapted to these high – elevation habitats. The results emphasize that there is a high undiscovered diversity of Mortierellaceae within the investigated glacier forefields. The isolation campaign of this study is an important initiative to preserve life from threatened environments.

Keywords: Glacier forefields, Cultivation, Mortierellaceae, Soil development, Pioneer communities

OP 2.6 - *Tyroliella, Cryptocalciella* and more: new taxa of Mortierellaceae from subalpine and alpine habitats

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The Mortierellaceae family comprises cosmopolitan soil-inhabiting fungi that can be found in almost all terrestrial habitats and are therefore considered an integral component of the core soil microbiome. Many species in this family are known to thrive in harsh environments, including highly exposed and nutrient-depleted terrains such as alpine soils or glacier forefields. In such environments, microbial communities are taxonomically and functionally diverse, making a significant contribution to nutrient cycling, soil organic matter formation, and plant establishment. However, the function of these communities is widely unknown, and it is becoming increasingly clear that the Mortierellaceae diversity in these habitats is largely unknown. We therefore isolated fungal strains from representative sites in subalpine *Pinus cembra* habitats, alpine dwarf willow habitats (*Salix herbacea*) and calcareous glacier forefields throughout the Italian and Austrian Alps. We characterised and identified the pure culture isolates based on morphology and barcode sequencing (rDNA ITS).

We applied using physiological tests, and detected associated bacteria. Whole genome sequencing and phylogenomics were applied to investigate the evolutionary relationships within Mortierellaceae. Our results confirm that Mortierellaceae diversity is high in these habitats. We detected 13 new species and two new genera: *Tyroliella* Telagathoti, Probst & Peintner and *Cryptocalciella* Mandolini, Szedlacsek & Peintner.

Keywords: Fungal diversity, Bacterial interaction, *Podila, Linnemannia, Entomortierella,* Marmolada

OP 2.7 - Bryophytes in Alpine glacial environments: insights from primary succession and functional ecology

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Global warming and the resulting glacier retreat are rapidly transforming Alpine ecosystems, exposing deglaciated surfaces that act as natural laboratories for studying primary succession. Bryophytes are among the first colonizers of these environments, yet in this context their diversity and ecological strategies remain poorly understood. We investigated bryophyte communities on two glacier forelands in the Italian Alps, Sforzellina (Sondrio province, Italy) and Trobio (Bergamo province, Italy), characterized by different geological and ecological conditions. Vegetation surveys along deglaciation chronosequences allowed characterization of species composition and colonization patterns from recently exposed substrates to surfaces deglaciated since the end of the Little Ice Age. Preliminary results highlight rapid bryophyte establishment following glacier retreat and shifts in species assemblages along substrate-age gradients, reflecting successional dynamics and environmental filtering.

To better understand the mechanisms underlying these patterns, we are developing a functional framework for mosses based for the first time on quantitative morpho-functional traits. An initial set of 21 traits was measured across species from lowland and high-elevation habitats to identify major axes of functional variation and ecological strategies. By combining glacier-foreland succession and functional ecology, this research provides new insights into bryophyte responses to environmental change in Alpine glacial environments.

Keywords: Bryophytes, Primary succession, Biodiversity, Functional traits, Alpine ecosystems

OP 2.8 - Efficiently assessing alpine soil fauna assemblages: classical sampling or eDNA metabarcoding? Or both?

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Alpine environments globally are changing fast but are still underrepresented in biodiversity studies. Therefore, assessment of groups such as soil fauna is urgently needed to better understand which fauna are actually living in alpine soils and how they respond to the challenges of Global Change. As classical methods (i.e., pitfall traps and soil cores) are reliable but time-consuming, the project BEN-EAF explores whether new eDNA methodologies are able to replace or support such classical approaches for soil animals.

Sampling will take in the Scottish Highlands where eDNA approaches have already been successfully tested for general assessment of soil biota. In four representative alpine habitats in the Cairngorms National Park, we test the applicability of (1) pitfall traps and soil cores vs. (2) DNA barcoding of animals captured by classical sampling, and (3) metabarcoding of eDNA obtained directly from the soil.

The aim of BEN-EAF is to identify the strengths and application area of all three approaches and to elaborate specific guidelines for alpine soil (fauna) samplings. The outcomes are expected to be not only beneficial for assessing the alpine soil fauna in the Scottish Highlands and the Euregio, but also for other alpine areas where soil fauna information is scarce.

Keywords: Alpine soil fauna, Environmental DNA, Soil invertebrates, Metabarcoding

OP 2.9 - Soil biodiversity responses to grazing management in South-Tyrolean Alpine grasslands

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South-Tyrolean alpine grasslands are biodiversity-rich ecosystems shaped by centuries of traditional livestock grazing. However, the reduction or abandonment of grazing can alter soil physical and chemical properties and biodiversity. The BIOPAS project focuses on how different managements influence soil composition, with the aim of identifying potential ecological tipping points. In two study areas, Vallelunga and Val di Funes, abandoned, intermediate, and grazed pastures (n = 30) were compared by integrating data on soil chemical parameters, aggregate stability, and the diversity of bacteria, fungi, and edaphic fauna, as investigated via DNA metabarcoding. Abandoned plots were characterised by distinct bacterial and fungal assemblages, including a greater relative abundance of Actinomycetota, Pseudomonadota and the rhizosphere-associated fungus Archaeorhizomyces.

Grazed plots showed shifts in bacterial composition and showed a greater relative abundance of grassland-associated fungi, particularly *Hygrocybe* and *Clavulinopsis.* Soil faunal communities also responded to grazing, with an increased relative biomass of annelids and a decrease in arthropod taxa. These biological shifts were generally more pronounced in Val di Funes, suggesting that grazing effects on soil biodiversity are site-dependent, highlighting the relevance of local conditions when evaluating management outcomes in alpine grasslands.

Keywords: Alpine grasslands, Grazing management, Soil biodiversity, eDNA metabarcoding, Site-specific responses.

OP 2.10 - Copepods coping with harsh environments: a case study in a deglaciating Alpine area

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Under progressive deglaciation, rock glaciers and paraglacial features will increasingly influence the biota of Alpine river networks: we investigated the copepod communities of different stream types within two catchments in a deglaciating area of the Italian Alps. We used an index of habitat mildness to measure the difference in community metrics over a gradient of habitat amelioration, driven by the mixing of distinct stream types and their interactions with paraglacial features.
The taxonomic metrics showed a bimodal distribution, peaking at intermediate mildness (one rock-glacial station) and at maximum mildness (one krenal station).
Bryophytes acted as local-scale multipliers of mildness as they store more detritus and provide shelter, and hosted a higher abundance of copepods. Community composition of rock-glacial sites differed from that of the other stream types, particularly from the glacial sites, and was similar to the rhithral and krenal ones.
Rock glacial streams may act as stepping stones facilitating copepods colonisation following glacier retreat and, after glacier loss, they may represent climate refugia for cold-adapted taxa and/or kryal specialists, because the slow thawing of their ice might sustain cold water conditions for a longer period of time.

Keywords: Rock glaciers, Biodiversity, Aquatic fauna, Benthos, Space-by-time substitution

OP 2.11 - Physical constraints drive diatom diversity and abundance in high altitude Alpine streams: Evidence from a field experiment.

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The “Window of Opportunity (WO) conceptual model” identifies the combination of milder physical and hydro-chemical conditions typical of late summer/autumn as the key drivers of the major growth stage of epilithic biofilm in glacial Alpine streams. A secondary late spring/early summer WO is expected to become more frequent due to the ongoing Alpine deglaciation and the related hydrological changes, especially reduction of snow cover and changing rainfall patterns. As the WO conceptual model has been scarcely verified in the field since its development, especially in non-glacial Alpine streams, we conducted a field experiment in a high-elevation area of South Tyrol (Lazaun, Italy). Water temperature, discharge and underwater light intensity were continuously recorded in three streams fed by glacier, rock glacier and till (millennia old glacial deposit) from June to October 2024. Water chemistry was determined on monthly samples, as well as abundance and diversity of epilithic diatoms on natural and artificial substrates.

The results confirm the autumn WO as valid in all stream habitats, as well as the driving role of physical constraints on diatom diversity and density throughout the season. The large and variable diatom biodiversity reflects the pronounced environmental variability that emerged even at a small spatial scale.

Keywords: High altitude streams, Window of Opportunity, Glacier, Permafrost, Epilithic diatoms

OP 2.12 - Sky Islands: Is isolation a barrier for Alpine freshwater insects?

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Alpine freshwater bodies, like mountain lakes or high altitude bogs, exist as a fragmented patchwork across the landscape. For organisms bound to freshwater, these habitats effectively function as isolated islands separated by an inhospitable terrestrial matrix. This raises the question: Are principles of island biogeography applicable to alpine freshwater biodiversity? Dragonflies and damselflies (Odonata) are an ideal system to test this. While their larvae depend on freshwater, adults are mobile flyers and they are widely used as indicators of general freshwater ecosystem health.

Combining 25 years of odonate observations across Trentino–South Tyrol with openly available and comprehensive geodata from OpenStreetMap, we tested whether isolation of 100 waterbodies affects species richness, community composition, or the distribution of individual species.
None of these biodiversity measures were influenced by isolation. Instead, local habitat characteristics, especially habitat composition and waterbody area, were the strongest drivers of dragonfly diversity.
This shows that alpine dragonfly metacommunity dynamics are primarily driven by large and diverse habitats, rather than by connectivity. Conservation efforts should therefore prioritize the protection of large, natural freshwater habitats, regardless of their isolation, rather than focusing on creating artificial habitats to enhance connectivity.

Keywords: Island Biogeography, Habitat isolation, Open data, Freshwater fauna

OP 2.13 - Uncovering cryptic diversity in Alpine *Ischyropsalis harvestmen*: genetic and morphological evidence for the revalidation of *Ischyropsalis tirolensis* and the role of glacial refugia in shaping diversification

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Mountain systems have played a major role in shaping the evolutionary history of low-dispersal organisms through repeated cycles of isolation and recolonization associated with Pleistocene glaciations.
The harvestman genus *Ischyropsalis* Koch, 1839 represents an excellent model for investigating these processes due to its narrow ecological preferences, limited dispersal ability, and strong genetic structuring.

Here, we combine genetic and morphological data to investigate species boundaries within the Alpine *Ischyropsalis* complex, focusing on *Ischyropsalis kollari* Koch, 1839, *I. ravasinii* Hadži, 1942, and populations historically attributed to *I. kollari* from the south-eastern Alps and the Dolomites. To clarify their evolutionary relationships, we reconstructed a multilocus phylogeny of Alpine *Ischyropsalis* using mitochondrial (COX1) and nuclear (28S, EF1α) markers. Genetic analyses reveal that these populations form a deeply divergent evolutionary lineage corresponding to *Ischyropsalis tirolensis* Roewer, 1950, currently treated as a junior synonym of *I. kollari.* Morphological examination supports its distinctiveness and provides diagnostic characters consistent with species-level recognition. Genetic structure suggests long-term isolation in distinct glacial refugia followed by limited postglacial dispersal. These findings highlight the role of Alpine microrefugia in generating and maintaining biodiversity and reveal overlooked diversity within a cold-adapted arachnid lineage. Our results support the revalidation of *I. tirolensis* and emphasize the value of integrative taxonomic approaches for uncovering cryptic diversity in mountain ecosystems. More broadly, this study contributes to understanding how glacial history has shaped diversification patterns in Alpine arthropods and provides a framework for future conservation assessments of narrowly distributed endemic taxa.

Keywords: Alpine endemism, Biogeography, Dolomites, Integrative taxonomy, Species delimitation

OP 2.14 - Damsels in Distress? Revealing historical patterns in endemicity & threats to damselflies of Peninsular India

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Odonates (dragonflies & damselflies) are freshwater insects and good ecological and climate indicators. Around 80 species of odonates are endemic to the Western Ghats of India.
Previous localized studies have indicated that odonate endemism hotspots are around areas of high-canopy forests and primary montane streams. To delineate landscape-level drivers of endemicity of damselflies, we looked into historical and contemporary geo-tagged data on species, their habitats, and climate.

We examined the effects of historical climatic fluctuations on the current geographical distribution of odonates and delineated landscape-level determinants of the geographical distribution of endemic species in the context of conservation. We collected data on 24 species (09 endemics, 15 non-endemics) through two-year-long field surveys across the 1600 km stretch of the Western Ghats at 144 sites. We supplemented our data with secondary sources, collecting 1633 data points. We performed Climatic Niche Modeling and back-projected the models in two historical time periods, the Last Glacial Maximum (~22 Ka) and Last Interglacial (~120 Ka). We further performed the ecological niche modeling (ENM) analysis using multiple predictors sourced through vegetation, climate, freshwater habitat, and topography layers. We also performed the Extent of Occurrence and Area of Occupancy analyses.

The study, a first-of-its-kind on odonates, indicated that non-endemics showed progressive expansion of suitable climatic areas over time, whereas suitable climatic areas of the endemics fluctuated. The suitable climatic areas occupied by endemic vs. non endemics differed significantly. ENMs indicated that endemics cluster in high-elevation areas with a high proportion of cloud cover and vegetation fraction. Our analysis revealed that all species urgently need an upgrade in their present IUCN status. Further, odonates of the global south urgently need to be reassessed for threats to prioritize their conservation.

Keywords: Conservation, Dragonfly, ENM, Threatened, Western Ghats

OP 2.15 - Behavioral response and latent heterogeneity shape abundance estimates in the unique population of *Triturus carnifex* in Trentino.

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Abundance estimates represent a fundamental parameter for amphibian conservation, especially in isolated populations facing a high risk of extinction. In this study, we investigated the demographic structure of the only known population of *Triturus carnifex* in the Autonomous Province of Trento using a Capture-Mark-Recapture (CMR) approach. Across four consecutive sampling sessions (May 2025), 302 individuals were captured using 45 funnel traps, and morphometric data (sex, weight, SVL) were collected to calculate the Scaled Mass Index (SMI). Population size and individual capture probabilities were estimated within a latent class modeling framework for closed populations. These models account for individual heterogeneity and behavioral responses to capture, two important sources of bias in short-term studies.

Spatial analyses based on K-means clustering showed that microhabitat variables (water depth, distance from the edge, and vegetation density) did not influence capture probability, which was instead driven by intrinsic biological factors and capture-induced behavioral responses.
The species' biology, together with the low recapture rate, suggests a high sensitivity to handling and capture stress. This pattern of trap-shyness was further supported by the Recursive model, which indicated a significantly lower capture probability for individuals previously captured.
Final population estimates ranged from 2312 individuals (Recursive model) to 2823 individuals (Log-linear model), with a female-biased sex ratio (SR = 0.43). These findings highlight the importance of integrating species-specific biological traits and behavioral responses into demographic analyses to obtain robust and reliable population estimates.

Keywords: Triturus carnifex, Capture-Mark-Recapture, Scaled Mass Index (SMI), Latent class model framework

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OP 2.16 - Beyond habitat characterization: using vegetation-derived Ecological Indicator Values (EIV) to inform forest management and conservation of *Salamandra atra aurorae.*

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Identifying habitat key drivers is crucial for the adoption of effective conservation strategies, especially for microendemic taxa. Vegetation-derived ecological indicator values (EIVs) act as integrated proxies for several microhabitat features that can affect animal abundance. Furthermore, EIVs integrate long-term abiotic conditions. In this study, we tested if EIVs could explain the abundance of *Salamandra atra aurorae*, a highly threatened microendemic amphibian, using repeated count data from 30 forest plots analyzed through Bayesian N-mixture models.

Our results show that salamander abundance is positively associated with soil aeration EIV and negatively with temperature EIV, while humus EIV showed a weaker positive effect. These findings provide ecological insights that can drive forest management and conservation.

To ensure the long-term persistence of *S. a. aurorae*, conservation strategies must prioritize maintaining a dense “forest shield” to buffer thermal stress, preventing soil compaction to preserve essential aeration, and promoting mixed forests with deadwood to enhance humus-mediated trophic complexity.
By linking fine-scale ecosystem properties to faunal abundance, this method offers a strategic tool for habitat management and monitoring of microendemic taxa habitat suitability in the face of global climate change and forestry exploitation.

Keywords: Bayesian modeling, Microendemism, Alpine ecosystems, Forest-floor complexity, amphibian

OP 2.17 - From genes to species to ecosystems: the Alpine newt as a biological indicator of wetlands vulnerability to environmental and climate changes

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Wetlands are biodiversity-rich, yet fragile ecosystems, highly impacted by exploitation, drainage, pollution, and, more recently, the climate crisis. Amphibians have been long recognized as keystone biological indicators of environmental health and could act as a proxy for wetland health assessment. Here, mouth swabs from Alpine newts (*Ichthyosaura alpestris*) and environmental DNA (eDNA) samples were collected from 14 wetland sites in the Province of Trento (Italy), including peat bogs, Alpine lakes, ponds, and a semi-natural farm pond. This study aimed at: i) for the first time, providing population genetic diversity data for this species in Trentino; ii) comparing diversity indices as measured from mouth swabs and eDNA samples; iii) associating site characteristics with genetic biodiversity to highlight possible fragilities of wetland habitats with respect to both anthropogenic pressures and climate change. Four mitochondrial DNA and three nuclear DNA markers were sequenced with a High Throughput Sequencing approach. Standard diversity indices (e.g., haplotype and allelic richness, inbreeding coefficient) were calculated and used to compare the two sample types, as well as to assess genetic 'health' of the populations in relation to site characteristics (e.g., altitude, water temperature). Lastly, specific vulnerabilities of each population and wetland to anthropogenic impact are discussed.

Keywords: Wetlands, *Ichthyosaura alpestris,* eDNA, Biodiversity

OP 2.18 - Temperature drives seed germination in the Alpine endemic *Sanguisorba dodecandra* Moretti: first insights into its reproductive ecology.

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Sanguisorba dodecandra Moretti is an endemic species of the Orobie Alps whose reproductive ecology remains poorly understood. Knowledge of seed germination requirements is essential for understanding the ecological processes regulating recruitment and persistence in Alpine plant populations. Seeds were collected in the upper Val di Scalve (Italian Alps) in August 2025 and stored under controlled conditions (<15% relative humidity and approximately 20 °C). Five pre-treatments were tested: no treatment, one and two weeks of cold stratification at 4 °C on moist paper, and one and two weeks of dry freezing at –20 °C. Germination tests were conducted over four weeks under two alternating temperature regimes: 10/5 °C and 35/25 °C.

Pre-treatments did not affect final germination percentages. Under the 10/5 °C regime, germination ranged from 80.0% to 86.7% across all treatments. In contrast, seeds exposed to 35/25 °C showed reduced germination, never exceeding 16.7%. These findings highlight the importance of temperature as a key driver of germination in *S. dodecandra* and suggest that recruitment is associated with cool environmental conditions typical of Alpine habitats. The study provides a first contribution to understanding the reproductive ecology of this endemic species and offers new insights into germination strategies of Alpine plants.

Keywords: *Sanguisorba dodecandra*, Seed germination, Reproductive ecology, Alpine biodiversity, Endemism

OP 2.19 - Listening to the mountains: innovative approaches for monitoring threatened Alpine birds

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Alpine environments are highly sensitive ecosystems increasingly affected by climate warming, land-use changes, and growing tourism pressure. Mountain specialist birds, adapted to harsh high-elevation conditions and often characterized by restricted ecological niches, are particularly vulnerable to these changes and represent valuable indicators of mountain ecosystem health.
This study focuses on four mountain specialist species occurring in the Alps: citril finch (*Carduelis citrinella*), wallcreeper (*Tichodroma muraria*), alpine accentor (*Prunella collaris*), and white-winged snowfinch (*Montifringilla nivalis*).

Monitoring these species is challenging because of their low population densities, patchy distributions, and high mobility, which can limit the effectiveness of conventional surveys and passive acoustic approaches. This study aims to develop and validate standardized, cost-effective monitoring protocols by comparing alternative field survey methods and optimizing detection probability, abundance estimates, and sampling effort.

During the 2026 breeding season, different survey protocols were tested across multiple breeding sites in South Tyrol. For the citril finch, 5-km linear transects focused on breeding evidence were compared with territory mapping. For cliff-nesting species, territory mapping was compared with fixed-duration observation points at potential nesting cliffs. Survey methods will be evaluated according to breeding pairs detected relative to sampling effort, providing optimized protocols for large-scale monitoring from 2027 onwards.

Keywords: Bird conservation, Census methods, Detection probability, Survey design, Population assessments.

OP 2.20 - Functional distinctiveness and rarity of Holarctic mountain birds and their vulnerability to climate

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Ecological communities are undergoing transformations in their composition due to climate change. The loss of both functionally distinct and geographically restricted (i.e., rare) species in those communities might lead to the loss of unique ecosystem functions. Mountain ecosystems host high levels of species diversity, and many species are often described as “unique,” yet few studies have investigated how unique they truly are and what this means in the current context, in which climate change is having particularly strong effects on mountain ecosystems. In this study, we investigated the relationship of species' functional distinctiveness, geographic restrictedness, and their combination (i.e. rarity), with the thermal niche for 800 mountain birds breeding in the Holarctic.
We found that mountain species associated with colder thermal niches perform unique functional roles within their ecosystems, and this functional uniqueness is more pronounced in mountains at high latitudes. Also, when linking geographical restrictedness to functional distinctiveness, we found that most rare species occur in mountain areas experiencing high rates of warming, like the Himalayas and the Caucasus mountains.

These results highlight the vulnerability of Holarctic cold-adapted species and mountain communities to climate change. Given the irreplaceable role of functionally unique species within ecological networks, we expect cold mountain regions in the Palearctic to be particularly susceptible to cascading species losses and climate-driven community disruptions. Conservation strategies should therefore focus on maintaining and restoring specialist species that perform unique ecological roles and on preserving climate refugia—areas capable of providing suitable habitat for these species in the future, regardless of climatic conditions.

Keywords: Climate change, Biodiversity, Functional traits, Mountain species, Birds

SPEED TALKS

ST 2.1 - Arthropod communities inhabiting an intact rock glacier at an unusually low altitude in the Carnic Alps

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Intact rock glaciers, containing ice-rich debris, are recognized as microclimatic refugia for cold-adapted species. Recent investigations revealed the occurrence of interstitial ice at an unusually low altitude (ca. 1800 m a.s.l.) within the forest-covered Razzo rock glacier in the Carnic Alps.
We investigated its role as a refugium for microthermal arthropod species threatened by climate warming. Using pitfall and MSS-tube traps, we sampled arthropod communities inhabiting both the surface environment and crevices where cold air flows are detected during the summer. Overall, we collected 581 arthropods, and preliminary identifications suggest the occurrence of cryophilic species.

Keywords: Alpine biodiversity, Permafrost, Extreme habitats, Ice-related landforms, Warm-stage refugia

ST 2.2 - Rising up after the ice: patterns of ground beetle community establishment following a glacier's disappearance

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Alpine glaciers are rapidly retreating and disappearing, leaving behind them substrates progressively colonised by warm-tolerant species, forcing the extinction of cryophilic species. During summer 2025, we investigated the colonisation patterns of ground beetle communities (Carabidae) along the foreland of the Trobio Glacier (Orobic Alps, Italy), extinct in 2023.
By comparing our data with those of a previous research, we describe the consequences of the glacier disappearance on the cold-adapted and cryophilic ground beetles occurrence.
Our preliminary results show an upward shift of almost all of the previously sampled species and the arrival of new lower elevation ones, colonising the foreland.

Keywords: Glacier extinction, Colonisation patterns, Carabidae

ST 2.3 - Glacier-fed Alpine streams as climate-sensitive hotspots: Temporal drivers of macroinvertebrate biodiversity

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Glacier-fed Alpine streams are biodiversity hotspots and among the freshwater ecosystems most exposed to climate change. We analysed long-term (since 2010) macroinvertebrate dynamics in the Saldur stream (Matsch/Mazia Valley) along an altitudinal gradient. Monthly sampling during the snow-free season revealed that discharge variability during snow- and glacier melt strongly structures communities. Peak melt reduced density and taxonomic and functional diversity, while temporal trends showed a slight decrease in richness at higher elevations and an increase in total abundance, mainly at downstream sites, with high interannual variability. These results highlight the need for long-term monitoring to disentangle climate-driven change from seasonal and interannual variability and to capture ongoing ecological changes.

Keywords: Alpine streams, Benthic invertebrates, Long-term monitoring, Climate change

ST 2.4 - Metagenomics identifies distinct functional and taxonomic profiles between freshwaters and associated sediments in alpine habitats

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Alpine freshwater habitats are vital biodiversity hotspots, yet their microbial dynamics across varying physiographies are poorly understood. We employed metagenomics to study sediment and water habitats across a depth and size gradient, from deep lakes to peat bogs, revealing that sediments generally harbor more diverse, even microbial communities with higher potential for nitrogen and methane metabolism. In contrast, water communities displayed greater heterogeneity, favoring photosynthesis and carbon oxidation. Notably, small water bodies like peat bogs exhibited higher taxonomic richness than larger lakes. With 73% of recovered genomes unassigned at the species level, these findings emphasize the vast, untapped microbial diversity within these fragile alpine ecosystems.

Keywords: Freshwater microbial ecology, Metagenomics, Biodiversity monitoring, Metagenome-assembled genomes, Functional analysis

ST 2.5 - Integrated ecosystem assessment of two Alpine lakes in the Adamello-Brenta Natural Park

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The glacial alpine lakes of Pradalago and Valagola, situated within the Adamello-Brenta Natural Park, are characterised by distinct geological substrates and varying degrees of anthropogenic pressure.

The study provided an ecological and trophic characterisation of the lakes through a multi-taxon analysis of biological communities (macrozoobenthos, zooplankton, phytoplankton, benthic diatoms, and macrophytes) and the assessment of water physicochemical parameters, nutrients, metals, suspended solids, and primary productivity (chlorophyll-a and biomass).

The results indicate oligotrophic conditions, with low nitrogen and phosphorus concentrations, high photosynthetic activity, and no significant environmental concerns. The assessment of benthic and planktonic fauna and flora, together with the study of macrophyte communities, enabled the compilation of taxonomic inventories valuable for scientific research, nature conservation, and environmental education and outreach.

Keywords: Invertebrate biological communities, Multi-taxon analysis, Trophy, Inventories, Outreach

ST 2.6 - Predation of bat bugs by synanthropic spiders in church roofs hosting large bat colonies in South Tyrol

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Large colonies of *Myotis myotis* (Borkhausen, 1797) and *Myotis blythii* (Tomes, 1857) inhabiting church roofs in South Tyrol support distinctive arthropod communities associated with guano accumulation. In two roosts (Gargazzone and Villa di Egna), we documented frequent predation of the bat bug *Cimex pipistrelli* Jenyns, 1839 by the spiders *Holocnemus pluchei* (Scopoli, 1763) and *Steatoda triangulosa* (Walckenaer, 1802). Bed bugs moving between bats and their refuges were repeatedly observed trapped in spider webs and subsequently consumed. These observations indicate that spiders constitute important predators of *C. pipistrelli* and highlight previously overlooked trophic interactions within bat-roost ecosystems.

Keywords: Spiders, Bat colonies, Bed bugs

ST 2.7 - Ten years of standardized bird monitoring in the Caldaro wetland: assessing the role of an Alpine biodiversity hotspot for migratory and breeding birds

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Lake Caldaro is one of the most important wetlands in the Euregio region and a key ecological corridor linking Mediterranean and Central European environments across the Alps. Its reedbed-dominated habitats support migratory and breeding bird communities, making the area a biodiversity hotspot of high conservation value. More than twenty years of bird ringing, including ten years within ISPRA's standardized MonITRing program, have produced one of the longest ornithological datasets in the region.
This effort relies on the collaboration of licensed ringers, a dedicated volunteer network and researchers. Using capture–recapture data, we assess the site's ecological importance and support conservation management.

Keywords: Wetland biodiversity, Bird ringing, Capture–recapture, Migratory birds, Ecological monitoring

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ST 2.8 - High-altitude survival in a warming world: the case of the white-winged Snowfinch (*Montifringilla nivalis*)

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Mountain species are particularly vulnerable to global warming, which reduces suitable habitat and increases isolation. The white-winged snowfinch (*Montifringilla nivalis*)'s strong philopatry and limited dispersal make population connectivity a conservation priority. Whole-genome data from 50 samples, across 11 localities in the Italian Alps and Apennines, were used to evaluate genomic variation and population structure. Individual genomic heterozygosity is similar and not particularly low in all Alpine samples (~0.0012), whereas Apennine individuals show a 20% reduction. The Alpine and Apennine populations are clearly different (Fst values of 10–15%), while Alpine populations share large fractions of their genomes. The population from Cima D'Asta (Trentino, Alps) shows larger differences between individuals, possibly due to immigration from different breeding areas.

Keywords: *Montifringilla nivalis,* Whole-genomes, Population genomics, Alps, Apennines

SESSION 3

Participatory and Collaborative Research

Session 3 - Participatory and Collaborative Research

This session explores the synergy between scientific research and community engagement, underlining how local communities' knowledge and collaborative approaches inform environmental stewardship.
The session will examine the role of citizen science and place-based collaborative projects in biodiversity assessment, while analyzing the deep interplay between landscape history and contemporary management practices, to ultimately produce ethically grounded, scientifically rigorous, and socially impactful participatory research.

ORAL PRESENTATIONS

OP 3.1 - 175 years of odonatological research in Trentino: from collections to participatory science

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The first odonatological records from Trentino date back to 1851, when Francesco Ambrosi reported seven species for the region. Since then, odonatological research has progressed with varying intensity.
By the beginning of the 21st century, most available knowledge was derived from 46 scientific publications and 10 scientific collections, of which those of the Science Museum of Trento harboured the great majority of specimens, covering a period between 1924 and 1957. Since 2017, an intensive survey of the regional fauna has been carried out, covering 231 sites to date and providing a comprehensive picture of the dragonfly fauna of Trentino.
Since 2006, data from citizen science platforms have been integrated into the database, and their contribution has steadily increased over time. This trend led to the launch of a formal citizen science project in 2024, which has now enrolled 61 participants.

Overall, 62 species have been recorded in Trentino (43% of the European fauna), of which five have not been contacted for at least 30 years. Trentino hosts nationally important populations of several peatland specialist species, including two of the three Italian reproductive populations of *Leucorrhinia pectoralis,* a species listed in Annexes II and IV of the Habitats Directive. The comparison between recent and historical records showed that at low elevations, nearly half of the known historical populations of dragonflies have disappeared, with a marked decline in specialists of temporary lentic and lotic habitats as well as cold-adapted species. Conversely, permanent-lentic generalists and warm-adapted species have increased, including the recent colonisation of the region by *Trithemis annulata*, which expanded northwards in response to climate warming and was first recorded by a citizen scientist in 2023.

Keywords: Odonata, Citizen Science, Monitoring, Faunistic, Trentino

OP 3.2 - Citizen science for soil biodiversity assessment and stewardship

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Soil biodiversity in alpine ecosystems remains poorly understood despite its fundamental role in ecosystem functioning, nutrient cycling, and resilience to environmental change.
Mountain environments are characterized by steep environmental gradients that create unique habitats and support highly specialized bacterial and fungal communities. However, large-scale information on soil biodiversity across alpine regions is still scarce.

Within the Horizon Europe project ECHO we engage citizens to assess soil health across Europe while increasing soil literacy. Through training and the use of co-developed soil sampling kits, participants measure 8 soil health indicators on-site in wide range of ecosystems, including alpine environments.
In addition, soil samples are shipped to our labs and analyzed for bacterial and fungal community via DNA metabarcoding using lab-based methods.

To date, nearly 7,000 records have been uploaded to ECHOREPO, an open access database, covering different land-uses. These data are currently being analyzed to investigate patterns of soil biodiversity. Alpine samples provide a valuable opportunity to explore how belowground biodiversity varies along elevation gradients and across different land-uses, improving our understanding of the ecological processes shaping mountain ecosystems. The results will contribute to the conservation and sustainable management of alpine environments, where belowground biodiversity remains underrepresented in monitoring and conservation strategies.

Keywords: Soil biodiversity, Citizen science, Biodiversity monitoring, Open data, DNA metabarcoding

OP 3.3 - Participatory discovery of values, conflicting perspectives, and technology opportunities related to grazing lands

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We report on a participatory research in an Alpine community in Northern Italy, where a heterogeneous panel of local stakeholders helped envision technological opportunities to support pasture-based farming as a key asset for high-quality milk and cheese production, deeply embedded in the region's cultural and ecological landscape. Local cheese production enabled us to examine the intricate entanglements among human practice, culture, nature, and biodiversity, and to envision opportunities for technologies that support awareness of trade-offs between biodiversity preservation and quality production. By analysing qualitative data collected through co-design workshops and interviews with 34 local stakeholders, we investigated how alpine rural communities engage with and frame nature through their participation in the traditional pasture-based farming system. The objective was to understand how digital interventions can be both respectful of and responsive to local socio-ecological realities.

Our analysis identified three themes that dissect how rural communities perceive, engage with, and care for their natural environment: navigating the tension between productivity and biodiversity; the undervalued economic dimensions of caring for nature; and nature as an arena for negotiating the fragile bond among nature, identity, and pasture-based farming.

In this context, data-driven technological interventions emerged as a basis for an informed dialogue among farmers, scientists, and policymakers.

Keywords: Alpine rural communities, Codesign, Pasture-based farming, Cheese production, Trade-offs

OP 3.4 - Enhancing biodiversity in intensive apple orchards through participatory nature-based solutions: the Schneewinkel Project

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Intensive agriculture is a major driver of biodiversity loss, causing declines in native flora and fauna. Apple orchards in South Tyrol, Italy, are similarly affected by machinery use, mulching, and crop protection measures.

The Schneewinkel Project, covering 70 hectares, aims to enhance biodiversity in organic apple orchards through Nature-based Solution (NbS). Initiated by local organic farmers, the project follows a participatory approach in which farmers voluntarily implement biodiversity-enhancing measures on their land. Thirty of the forty farmers in the project area have adopted one or more measures, including flower strips, shrub and non-crop tree plantings, nesting sites for wild bees, and nest boxes for birds and bats. While technical support and materials are provided by the project, implementation and long-term maintenance depend on farmers' active participation.

Baseline surveys of birds, bats, butterflies, bees, and other pollinating insects were conducted before implementation. Birds, bats, and butterflies are monitored using BMS methodology, while bees, hoverflies, and other flying insects are surveyed with UV-reflecting coloured pan traps. Monitoring will be repeated to assess biodiversity responses and the effectiveness of the measures. As a pilot initiative, the project aims to facilitate transfer of successful measures to other intensive fruit-growing regions.

Keywords: Agroecology, Biodiversity enhancement, Apple orchards, Nature-based Solutions, Participatory approach

OP 3.5 - Ecosystem diversity and cultural ecosystem services in mountain highlands: An integrated assessment of supply, use and human pressures

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Mountain highlands provide a wide range of Cultural Ecosystem Services (CES) that contribute to human well-being but are increasingly affected by recreational use and related pressures.
Growing tourism and outdoor activities may threaten ecosystem integrity and the sustainable delivery of cultural benefits. Understanding how different ecosystems contribute to CES, how these services are used and where human pressures concentrate remains a key challenge for mountain management. This study proposes an integrated framework to assess CES by jointly analysing potential supply, actual use and pressures across CES categories and ecosystem types in the Noce River basin (Trento Province, Italy).

Potential CES supply and demand were mapped using survey-based stated and revealed preferences, including visitation frequency, travel cost, willingness-to-pay and accommodation capacity. Actual CES use was assessed through georeferenced social media data and tourism infrastructure use. Pressures were evaluated through stakeholder consultations to derive risk scores, and surveys for visiting intensity.

Results show strong mismatches between potential CES supply and actual use across ecosystem types. Recreational and sport activities are concentrated in alpine and cryospheric environments, highlighting areas where tourism pressure may exceed ecological sustainability.
Nature observation services appear underutilized, suggesting opportunities to improve accessibility and awareness. Aquatic ecosystems emerge as particularly vulnerable, requiring precautionary conservation and visitor management.

The study highlights the importance of distinguishing potential CES supply from actual use and integrating pressure indicators into CES assessments. The framework supports sustainable mountain management by linking ecosystem diversity, cultural benefits, and human pressures in decision-making.

Keywords: Cultural ecosystem services, Landscape diversity, Mountain ecosystems, Recreation pressure, Sustainable management

OP 3.6 - Turning Climate-Smart Forestry into action: Insights from ALPFOR-CSF

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Climate change is increasingly affecting European forest ecosystems, intensifying natural disturbances and challenging traditional silvicultural approaches. In the Italian Alps, where many stands are dominated by Norway spruce, these pressures call for adaptive management strategies able to strengthen forest resilience while supporting biodiversity and structural diversity.

ALPFOR-CSF (Climate Smart Forestry and management adaptations of Alpine mountain forests) is a pilot project that translates Climate-Smart Forestry (CSF) concepts into practical management. Developed in collaboration with the Forest Service of the Autonomous Province of Bolzano, the project compares conventional thinning with innovative treatments designed to improve stand heterogeneity by looking at both structure and composition. Additional planting of other species, including silver fir, is also planned to promote more diverse and resilient future stands.

The project combines field surveys with advanced monitoring techniques, including UAV-based photogrammetry and laser scanning, to assess post-intervention dynamics from individual trees to stand structure. Key indicators include growth, spatial structure, soil carbon, microclimate, deadwood, and tree-related microhabitats, following the Climate-Smart Forestry guidelines developed within the Horizon-EU FORWARDS project.

A central component is the co-production of knowledge with forest managers, exploring opportunities and barriers to the adoption of adaptive silviculture within existing management frameworks. ALPFOR-CSF provides a real-world testbed for embedding Climate-Smart Forestry into Alpine forest decision-making.

Keywords: Climate-Smart-Forestry, Adaptive forest management, Structural diversity, Alpine forests, Ecosystem services

OP 3.7 - Mismatch between ecological evidence and public's perception of the bark beetle outbreaks in the spruce forests of the Italian Alps

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Spruce forests in the Italian Alps have high ecological, cultural, and landscape value, yet they are being visibly transformed by unprecedented bark beetle outbreaks. We investigated changes in plant and soil arthropod communities across six transects representing a disturbance gradient using vegetation relevés, pitfall traps, and the QBS-ar index. To assess public's perception of the phenomenon, we also conducted an online questionnaire that received 2,064 responses.

Our results suggest that taxonomical and functional diversity are not negatively affected by bark beetle activity, as expected, and may increase when disturbed stands regenerate naturally, maintaining favorable conditions for forest taxa. A clear mismatch appears to exist between ecological evidence and public's perception of the bark beetle phenomenon. Younger and better-informed people tend to hold a more optimistic view, whereas others tend to perceive the outbreaks primarily as a sign of environmental degradation. Given the increasingly diverse ways in which these forests are used today, we argue that, where stand conditions permit, post-disturbance natural regeneration might be a viable management strategy. At the same time, investing in education, particularly aimed at older and less informed segments of the population, could produce a shift towards a more positive perception of the bark beetle issue.

Keywords: *Ips typographus*, Vegetation, Soil-arthropods, Biodiversity, Social perception

OP 3.8 - Stakeholders' perspectives on riparian zones across Europe: Shared views and regional contrasts

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In the framework of the BIODIVERSA+ RIPARIANET project, we surveyed stakeholders' views on the ecological roles, threats, and management needs of riparian zones across five European countries (Sweden, Germany, Spain, Portugal and Italy). Responses from more than 500 participants show strong alignment between scientists and practitioners. Approximately half of all respondents considered their local river basins to be in low to moderate condition. Perceptions of key threats and management priorities varied regionally. Ultimately, our large-scale survey revealed both shared and divergent stakeholders' perspectives that mirror the environmental and ecological characteristics of riparian zones across Europe's boreal, continental, Atlantic and Mediterranean ecoregions.

These findings underscore the need to strengthen support for riparian conservation and restoration across the EU. Moreover, the responses can be interpreted within a space-for-time approach in view of future climatic change: the issues and challenges highlighted by southern countries could offer insights on how perspectives might evolve at higher latitudes as temperatures rise or as invasive species migrate toward higher latitudes. Potentially, this might prepare practitioners and managers of riparian zones in northern regions for future impacts and thereby enable more effective management plans for riparian conservation in the future.

Keywords: Stakeholders survey, Expert knowledge, Riparian biodiversity, Questionnaire

OP 3.9 - The role of social research in the planning and implementation of environmental studies

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Participatory research, such as citizen science, offers a powerful framework for integrating community knowledge into scientific inquiry, fostering environmental stewardship through active engagement. Natural environments encompass intertwined physical (e.g., temperature, air quality, biodiversity) and psychological (e.g., place attachment, restorativeness) dimensions, and understanding both requires multidisciplinary, community-grounded approaches. Toward social-STEM collaboration in biodiversity research, we present the results of a citizen science project conducted from October 2025 to June 2026 at the Liceo Quadri in Vicenza.

The research project, aimed at investigating eco-emotions (i.e., individual emotional responses to adverse climate change events), sought the participation of 12 students from the institute in a series of 8 meetings to choose the research questions, plan, organise, prepare the materials, analyse the data, and interpret the results. The students collected data on different outcome variables, namely eco-guilt, eco-anxiety, ecological grief, General Ecological Behaviour and climate enthusiasm, via the construction of online surveys. From a sample of 261 participants, preliminary results reveal meaningful differences in emotional responses by age (adults v. youngsters), gender, and rural or urban context. We argue that such participatory, psychology-informed projects constitute a methodological procedure transferable to biodiversity assessment, particularly in mountainous communities, where emotional and ecological dimensions of landscape are deeply connected.

Keywords: Citizen Science, Eco-emotion, Environmental Psychology, Multidisciplinary research approaches

OP 3.10 - BiodiversitARB: A participatory framework for ecological assessment of Nature–Business interdependencies in Italian SMEs

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Business and Biodiversity Assessment, 2026), site-level ecological data on nature–business interdependencies remain largely absent from both scientific monitoring programmes and corporate practice — particularly for small and medium enterprises (SMEs).

This contribution presents BiodiversitARB, a participatory framework that engages Italian SMEs as active data providers in the structured assessment of their biodiversity impacts, ecosystem-service dependencies, and ecological vulnerabilities.

The methodology integrates open-access ecological integrity indicators — Mean Species Abundance (MSA) and Areas of Global Conservation Value (AGCV) — with GIS-based spatial screening of proximity to Natura 2000 sites, combined with company-level dependency assessment using the ENCORE database and Taskforce on Nature-related Financial Disclosures (TNFD) LEAP logic. Results are structured as nature-related double materiality profiles, accessible to organisations without prior expertise related to environment, social and governance (ESG). Pilot applications with three Italian SMEs (two in Veneto, one in Sicily) demonstrate that participatory corporate engagement can generate primary ecological data on ecosystem–business interactions otherwise absent from conventional monitoring. Citizen-science tools — iNaturalist for georeferenced species observations and bug hotels as micro-habitat structures for employee engagement — complement the analytical assessment. A Mascot component links each company to a locally threatened species selected from verified Red Lists, producing additional georeferenced occurrence data and strengthening ecological stewardship within the organisation.

BiodiversitARB offers a replicable model that repositions SMEs from passive reporting subjects to active contributors in biodiversity research and territorial ecological governance.

Keywords: Biodiversity assessment, SME engagement, Participatory research, ecological integrity indicators, citizen science

OP 3.11 - A systematic review of the role of community science in European wildlife governance

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Community science (CS) is vital for wildlife monitoring, but its translation into concrete governance outcomes remains unclear. Within the TransWILD Biodiversa+ project, we conducted a systematic literature review following PRISMA including European studies on CS activities to examine what impact authors think CS should have on wildlife governance. Authors-reported recommendations were classified using the IUCN-CMP Unified Classification of Conservation Actions Needed.

This filtering resulted in 70 relevant studies. Mammals were the most represented taxonomic group (n=43), followed by birds (n=24), invertebrates (n=10), reptiles (n=9), fishes (n=7), and amphibians (n=7) with direct observations as the type of data most collected. Most of the studies had Land/Water Management (n=42) as a type of author's recommendation, followed by Law and Policy (n=22), Species Management (n=21), Education and Awareness (n=17), Land/Water Protection (n=12). Land/Water Management spanned from problematic/species control to road-kills mitigation, while 'Policy and Law' had a prevalence of generalized or “soft law” recommendations. In conclusion, while CS is highly valued for practical management solutions, its formal policy impact remains underutilized and poorly documented in peer-reviewed literature. To bridge the science-policy gap, further research must systematically analyse and unpacking CS project reports and grey literature to unlock CS's true real-world governance outcomes.

Keywords: Community science, Literature review, Wildlife management, Wildlife governance, Policy

OP 3.12 - The project Waterwise: co-designing suitable management solutions for resilient Alpine headwaters

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Climate change and increasing human pressures are impacting the availability and quality of mountain headwaters. The project AS Waterwise aims to establish, together with stakeholders, a reference framework to assess headwater vulnerability and facilitate the design of sustainable management strategies and long-term adaptation. The design and validation of this methodology are strongly based on a bottom-up approach, involving local stakeholders and policy makers through interviews and dedicated workshops, in a participatory framework that integrates scientific evidence with local priorities, practices, and decision-making contexts.

The vulnerability assessment is being tested at catchment level in 8 pilot sites distributed in 6 countries of the Alpine Space, integrating climate modelling, water quantity and quality, biodiversity, socio-economic aspects, and information collected through citizen science activities (CrowdWater).
We are testing possible approaches to integrate biodiversity into the vulnerability assessment protocol by combining a habitat-based approach (wetland mapping) with the concepts of patrimonial (plants and Odonata protected species) and functional (epilithic diatoms) biodiversity. The experience gained from the pilot sites during the project will be expanded to the whole Alpine region through the production of protocols and guidelines for vulnerability assessment, and the creation of an online platform for data management.

Keywords: Waterwise, Alpine Space, headwaters, Vulnerability assessment

OP 3.13 - Citizen science for tick surveillance and human exposure assessment: Insights from ZeccApp, the first Italian participatory initiative

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Ticks are hematophagous arthropods that are widespread across the Alpine region and act as vectors for a wide range of pathogens. As their life cycle involves multiple vertebrate hosts, they represent an optimal study model to link biodiversity, human health and environmental factors. Traditional tick surveillance based on field sampling and host monitoring is effective but limited by high costs and logistical constraints. In this context, citizen science is emerging as a complementary approach to expand surveillance capacity and address knowledge gaps, particularly regarding tick presence and human–tick interactions.

In Italy, ZeccApp represents the first national citizen science initiative dedicated to tick surveillance. The mobile application enables stakeholders and the general public to submit georeferenced photographs of ticks and complete a questionnaire reporting habitat, host type, tick attachment status (questing or feeding), and human activities at the time of exposure.
All records are validated by experts to identify tick species and made available through an interactive map.

Preliminary results from the first monitoring season show good public engagement and a growing dataset of tick records across diverse environmental contexts, spanning wide spatio-temporal scales. Beyond mapping tick distribution, the data provide insights into human exposure patterns and risk behaviors. The project also highlights the main challenges of this approach, including reporting bias, uneven spatial coverage, and variability in image quality.

Overall, these findings underline the value of citizen science as a complementary tool for tick surveillance. By combining community participation with expert validation, this approach supports a more comprehensive data collection and improves our current understanding of tick presence and exposure factors across Italy.

Keywords: Ticks, Surveillance, Citizen science, One Health, Ecology

SPEED TALKS

ST 3.2 - Blumenwiesen–Prati fioriti

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Extensively managed grasslands are among the most species-rich habitats but have become increasingly rare due to intensification, abandonment, and land-use change. In urban environments green spaces face biodiversity loss through land sealing and intensive management. The Blumenwiesen–Prati fioriti project promotes the establishment of extensively managed meadows using autochthonous seed material on public green spaces.
Several municipalities in South Tyrol participate in the project and are supported through workshops and collaborative implementation. In order to evaluate biodiversity development colour-index assessments by municipal staff and scientific surveys of flora and fauna are conducted. This project, sponsored by Südtiroler Sparkasse, is a multi-stakeholder collaboration in order to enhance biodiversity in public green spaces.

Keywords: Urban biodiversity, Public green spaces, Autochthonous seed material, Participatory restoration

ST 3.3 - Collaborative wildlife monitoring: integrating camera-trap data in Friuli Venezia Giulia

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Various stakeholders, including forest rangers, wildlife managers, and hunters, routinely collect wildlife camera-trap data across the alpine and pre-alpine landscapes of Friuli Venezia Giulia. However, these datasets remain fragmented and rarely integrated. This project will combine existing resources with a standardized grid-based camera-trap sampling design across diverse mountain habitats. By integrating heterogeneous data with structured monitoring, we will develop efficient, cost-effective methods to estimate wildlife abundance and distribution, supporting science-based management decisions. The approach will strengthen regional wildlife monitoring while fostering long-term collaboration among stakeholders.

Keywords: Camera-traps, Hunters, Mammals, Wildlife management, Stakeholders

ST 3.4 - The Animal Biodiversity Monitoring Project: twenty years later

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In 2006, the Gran Paradiso National Park started a field program to determine the factors influencing animal biodiversity along altitudinal gradients and assess the risk of biodiversity loss. The monitoring effort is carried out for 2 years and repeated every five (2006-2007, 2012-2013, 2018-2019, 2024-2025) and will be maintained over time to highlight the response of alpine biodiversity to environmental changes. Seven taxa have been sampled (Carabidae, Staphylinidae, Araneae, Formicidae, Orthoptera, Lepidoptera, Aves), using semi-quantitative sampling techniques. After twenty years of monitoring, it is possible to identify current and future vulnerabilities both in terms of sensitive species and habitats.

Keywords: Multitaxa, Long-term monitoring, Grassland vulnerability

ST 3.5 – Mapping mountain biodiversity through citizen science: methodological issues and the experience of the "Neptis" project on butterflies

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Citizen science is significantly increasing the capacity to map and monitor biodiversity, by gathering large amounts of records over large areas. However, records are usually heterogeneous in quality and affected by biases.

We will illustrate how we are addressing these issues for the "Neptis" project, which aims at improving the knowledge on the distribution of butterflies (Papilionoidea) across South-Eastern Alps, within a few years. The project is supported by Padova University and Dolomiti Bellunesi National Park. Over three years, we invited volunteers to contribute records, and supported them with courses, field trials and progress reports. More than 300 volunteers joined the project and contributed >85,000 records. Additional records were digitized from publications and collections. To evaluate the reliability of species identification, location and date of each record, we are applying an explicit and uniform protocol to all records, considering all major sources of errors (e.g.: difficult discriminability of similar species, variable skills of volunteers) and checking voucher photos and specimens. We will employ the curated database for modeling species distribution, accounting for biases. The database will become available for further research and conservation, and the results of analyses will be published in a monograph and a web site.

Keywords: Papilionoidea, Mountain, Citizen science, Occurrence records, Data reliability

ST 3.6 - Exploring information overlaps between soundscape ecology and human perception: An assessment in the Euregio Region

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Eco- and bioacoustic monitoring are traditionally long-term, while human-centric soundscape studies rely on short-term acoustic schemes designed to simulate binaural human hearing, coupled with questionnaires to capture people's perceptions. The objectives of these two fields are different, causing them to historically operate in parallel. However, because they frequently operate within the same environments, this spatial overlap suggests that measurements collected for human soundscape assessment might provide secondary insights into localized biodiversity as a form of side information. Moreover, ecoacoustic data may offer useful, indirect context for human perception, revealing crucial information overlaps between approaches.

To investigate potential synergies, this study utilizes data collected within the framework of the "Silenzi in Quota" initiative and the "Soundscapes for All" project. Data were gathered across more than ten soundwalks (i.e. structured, participatory walks focused on active listening within the acoustic environment) conducted within the territory of Trentino-South Tyrol. More than two hundred participants evaluated Alpine environments using standardized questionnaires, while simultaneous short-term binaural recordings were collected. From these single recordings, objective acoustic metrics, psychoacoustic parameters, bioacoustic and ecoacoustic indices were extracted. Based on this dataset, we present preliminary findings exploring the associations between objective eco- and bio-acoustic indicators and subjective human perception.

Keywords: Soundscape, Perception, Biodiversity, Bioacoustics, Ecoacoustics

ST 3.7 - Integrating farmer knowledge and digital innovation to assess and communicate ecosystem services in heritage pasture systems of Val di Sole

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Mountain pasture systems represent some of the most biodiverse and culturally significant agricultural landscapes in the Alps. Beyond livestock production, these heritage systems provide essential ecosystem services and maintain the local landscape identity. However, increasing pressure from globalized food markets and declining profitability threatens the long-term viability of mountain livestock farming.

The SAGE project (Sustainable Alpine Grazing Ecosystems) addressed these challenges through a participatory, human-centered design approach implemented in Val di Sole (Trentino, Italy). Through a series of workshops, field visits, and iterative co-design activities, farmers, technology developers, and local stakeholders contributed to the development of a digital ecosystem-service assessment framework.

Local ecological knowledge was integrated with PLF (Precision Livestock Farming) technologies, including weather stations, satellite observations, tracking systems, soil sensors, farm records, and vegetation survey databases. The automated data collection channels created a transparent and reproducible framework for ecosystem service self-assessment resistant to tampering.
The data streams support key 12 indicators: 1) water regulation, 2) erosion protection, 3) soil conservation, 4) nutrient cycling, 5) forage provision, 6) grazing sustainability, 7) climate resilience, 8) habitat provision, 9) vegetation diversity, 10) landscape heterogeneity, 11) ecological connectivity. Automatically generated visualization schemes were developed to communicate the different values along the food production chain or to final consumers.

In conclusion, the methodological approach developed within the SAGE project demonstrates how participatory research can bridge scientific and local knowledge to support biodiversity conservation and the long-term sustainability of Alpine pastoral landscapes.

Keywords: Ecosystem Services, Participatory Research, Precisione Livestock Farming, Alpine Pastoral Systems

ST 3.8 - Shepherding for biodiversity: Evaluating targeted grazing as Nature-based Solution for invasive plant management

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Invasive alien plant species threaten ecosystems and human health. Riverbanks often serve as invasion hotspots, facilitating the spread of these species into surrounding habitats while creating major management challenges for authorities.

Shepherding is a nature-based landscape management practice with deep local roots. In recent years, grazing by sheep and goats has returned to the banks of the Adige River in South Tyrol, where livestock browse invasive vegetation and, thus, provide valuable ecosystem services.
This collaborative project between the Local Heritage Society, shepherds, and a botanist evaluates the effectiveness of targeted grazing and volunteer-led manual removal in controlling alien plants. Using an intervention study design, changes in plant biodiversity are assessed across four treatment variants at five randomly selected sites along the Adige River between Vadena and Salorno (BZ, Italy).

The results will inform evidence-based policy recommendations for the use of shepherding in vegetation management and raise public awareness of invasive alien plants. The initiative was co-funded by the Landscape Fund of the Autonomous Province of Bolzano–South Tyrol (CUP: B11G25000190001) and local sponsors.

Keywords: Vegetation survey, Sheep grazing, Alien vegetation control, Environmental stewardship, Science to policy

SESSION 4

Biodiversity patterns and interactions: from genes to ecosystems

Session 4 - Biodiversity patterns and interactions: from genes to ecosystems

This session aims to accommodate general contributions on biodiversity patterns at multiple organizational levels, with a focus on conservation relevance. The session includes two specific topics, as follows:

i. Biodiversity conservation and nature restoration under global changes

As traditional conservation strategies face the unprecedented speed of the Anthropocene, this session examines novel studies applied to Nature Restoration.
The discussion will center on the effects of climate change, environmental alterations and anthropogenic impacts on novel ecosystems, and thus enabling the future policy for biological diversity that has no historical analog.

ii. Integrated ecosystem dynamics, synergies among microbial networks, trophic complexity and global health resilience

This topic addresses the relevance of multidisciplinary, holistic studies to examine the systemic connectivity between microscopic (microbiomes) and the macro-ecological biodiversity, intended as a dynamic, multi-scale system where trophic complexity and non-linear interaction networks could determine ecosystem stability and resistance.

ORAL PRESENTATIONS

OP 4.1 - Polyploid plants in the Eastern Alps: insights from extensive sampling across elevational gradients

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Polyploidy, the presence of more than two chromosome sets in somatic cells, is widely recognized as an important feature of plant biodiversity. At global scales, an increase in polyploid frequency with latitude suggests a role of temperature in shaping the distribution of polyploid plants. However, patterns at finer, regional scales remain unclear. Here, we investigate how polyploid frequency varies along elevational gradients in the Eastern Alps. We analyzed a flora-wide dataset of approximately 42,000 georeferenced angiosperm samples collected along 101 elevational transects. Ploidy levels were determined using flow cytometry, resulting in a comprehensive cytogeographic dataset for the region.

Contrary to expectations based on global patterns, polyploid frequency decreased with increasing elevation. Below the timberline, it increased with distance from glacial refugia, particularly among species with limited dispersal ability, suggesting an influence of postglacial colonization dynamics. Within species exhibiting multiple ploidy levels, cytotypes did not show consistent elevational segregation. Broad-scale niche differentiation was variable across species and often not statistically supported, with climatic variables generally more important than soil factors. Overall, these results highlight the role of regional historical and ecological processes, particularly dispersal and postglacial history, in shaping polyploid distributions.

Keywords: Elevational transects, Biodiversity, Alpine flora

OP 4.2 - Vertical and horizontal ecological pathways shape Alpine ungulate responses to wolf recolonisation and human pressure

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Human-induced environmental change is reshaping ecosystems worldwide, altering species interactions and community structure. In the Alps, recovering ungulate populations and natural wolf (*Canis lupus*) recolonisation provide an opportunity to investigate how predator-driven (vertical) and interspecific (horizontal) ecological pathways jointly influence wildlife responses under increasing human pressure. We examined behavioural and trophic responses of three sympatric ungulates — red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), and Alpine chamois (*Rupicapra rupicapra rupicapra*) — across a gradient of wolf establishment and human activity in the south-eastern Alps (Trentino/Südtirol and Lombardy, Italy).

Using complementary datasets from camera-trapping, stable isotope analysis, and genetic metabarcoding, we evaluated changes in behaviour, resource use, and species interactions. Predator-driven non-consumptive effects emerged following wolf recolonisation, with red deer becoming more diurnal and forming larger groups in summer. These changes occurred alongside fine-scale interspecific co-occurrence, isotopic niche differentiation, and dietary segregation among ungulates, suggesting structured horizontal partitioning within the community. Interestingly, horizontal interactions were further modulated by wolf presence. Hunting, outdoor recreation, and human infrastructure further altered and, in some cases, overrode wolf-induced responses. By integrating vertical and horizontal ecological pathways, our study highlights how wildlife recovery, species interactions, and human activities jointly shape Alpine mammal community dynamics in rapidly changing mountain landscapes.

Keywords: Wildlife recovery, Anthropogenic influence, Ecological complexity, Large herbivore, Multi-disciplinary

OP 4.3 - Challenges and opportunities related to cross-border cooperation in the Alpine and Central European area within the framework of National Nature Restoration Plans under Regulation (EU) 2024/1991

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The Alps and Central and Northern Europe constitute a single ecological system in which ecosystems, wildlife populations, and natural processes are distributed without regard to administrative boundaries. The main environmental challenges of these territories, from habitat fragmentation to the management of ecological corridors and river basins, to the effects of climate change, have a clear cross-border dimension and cannot be effectively addressed within the borders of individual states.

Within this framework, Regulation (EU) 2024/1991 requires each Member State to draw up its own National Nature Restoration Plan. There is therefore a risk that separately prepared plans will produce interventions that are not fully consistent with each other, leading to a fragmentation of interventions precisely along state borders where greater ecological and management continuity is needed. This research explores the rationale and methods for developing a collaborative approach among the various restoration plans in the Alpine and Central European regions, where ecological continuity, the presence of shared mountain territories, and protected areas require strengthened forms of coordination.

The paper examines the legal frameworks for joint implementation of restoration measures, the forms of cooperation already available at the regional and cross-border levels, such as the experience of the Tyrol-South Tyrol-Trentino Euroregion, and the conditions that favor their development. Nature restoration in the Alpine region should not be interpreted as a simple sum of national interventions but as a shared process based on the ecological continuity of the territories and the capacity of administrations to cooperate across borders.

Keywords: Nature restoration, Regulation (EU) 2024/1991, Cross-border cooperation, National restoration plans, Alpine ecosystems

OP 4.4 - Uncovering nonlinear responses of mountain bird communities to climatic and vegetation gradients

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Mountain ecosystems harbour unique biodiversity but are increasingly exposed to the combined effects of climate and land-use change. Birds are widely used as indicators of environmental conditions, yet the relative importance of climatic and vegetation factors in shaping mountain bird communities remains incompletely understood. Addressing this knowledge gap is crucial for anticipating biodiversity responses to ongoing environmental change in mountain regions.

We investigated the influence of climatic and vegetation gradients on bird community structure across a broad elevational range in the Italian Alps. Bird surveys were conducted at 143 sites spanning diverse climatic and habitat conditions. We examined multiple facets of community structure, including species richness, taxonomic diversity, functional diversity, and the occurrence of mountain specialist species. To capture potentially complex ecological responses, we modelled associations between community attributes and environmental gradients using Multivariate Adaptive Regression Splines (MARS).

Our analyses reveal previously overlooked nonlinear relationships between environmental gradients and multiple dimensions of bird community structure, highlighting the complex interplay between climate and vegetation across alpine landscapes. These findings provide new insights into the ecological processes shaping mountain bird communities and contribute to a better understanding of how alpine biodiversity may respond to future environmental change.

Keywords: Alpine birds, Climate change, Functional diversity, Elevational gradient, Mountain ecosystems

OP 4.5 - From refugia to connectivity: conserving *Lepus timidus* while supporting biodiversity conservation and nature restoration in the changing Alps

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Mountain ecosystems are climate-sensitive biodiversity hotspots and valuable natural laboratories for studying conservation under global change. Using the mountain hare (*Lepus timidus*) as a model species, we explore how climate-driven shifts in species distributions, ecological interactions, and habitat connectivity influence biodiversity patterns and conservation outcomes in the Alps. Previous modelling studies predicted that rising temperatures could modify species coexistence, increase the risk of hybridization with the European hare (*Lepus europaeus*), and compromise the long-term persistence of mountain hare populations. Recent genetic evidence supports these predictions, revealing ongoing changes in species interactions and habitat use.

We assess the effect of climate-induced habitat fragmentation across alpine landscapes.
Our analyses indicate that suitable habitats for the mountain hare are increasingly restricted to isolated high elevation refugia, reducing ecological connectivity and potentially limiting gene flow among populations. Protected areas remain key conservation strongholds, but connectivity through corridors and buffer zones is essential for resilience and restoration. We discuss how coordinated monitoring networks and harmonized biodiversity data collection across the Alps, as promoted within the AlpsLife project, can improve our understanding of emerging ecological dynamics, support adaptive conservation strategies, and inform biodiversity policies aimed at addressing the challenges posed by novel ecosystems in the Anthropocene.

Keywords: Climate change, Mountain hare, Habitat connectivity, Alpine biodiversity, Conservation planning

OP 4.6 - Climate-mediated bottom-up pathways in Alpine seed consumers: from forest resources to space use and population dynamics

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Alpine forests are increasingly exposed to climate warming and disturbance, with potential cascading effects from primary producers to wildlife consumers. Using long-term data collected in five sites in the Central Italian Alps between 1999 and 2019, we examined *Sciurus vulgaris* as a model to link climate-sensitive forest productivity, pulsed resources, space use and population dynamics. We integrated three connected levels of the same producer-consumer system: climate effects on conifer masting, behavioural responses to resource distribution, and demographic responses to climate, resource availability and forest disturbance. Seasonal temperature and precipitation influenced cone production 1–2 years before seed maturation, providing the first step of the cascade. Pulsed seed availability then shaped the resource landscape experienced by red squirrels. Because *S. vulgaris* uses overlapping, non-territorial home ranges (n = 139), space use likely mediates access to heterogeneous and temporally variable resources.

Forest conditions were further assessed using NDVI as an indicator of forest disturbances, such as extreme weather events causing downed logs, wildfires, and insect outbreaks. At the population level, ARIMA models revealed biennial density fluctuations and delayed density responses to pulsed seed production, while warmer spring conditions were associated with higher density, likely due to improved reproductive output and survival rates. This integrated framework shows that climate change may affect Alpine red squirrels not only through direct weather effects, but also by reshaping the timing, magnitude and spatial distribution of forest resources. By connecting abiotic forcing, forest productivity, consumer behaviour and demography, this study addresses biodiversity responses across organisational levels and provides insight for managing Alpine forest consumers under global change.

Keywords: Resource pulses, Home-range overlap, Global change, ARIMA models, NDVI

OP 4.7 - From extreme weather events to disease risk: Ecological responses of small mammals and ticks in the Italian Alps

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Climate change is causing more frequent and more intense extreme weather events altering ecosystems globally, with mountain regions being particularly vulnerable. In 2018, the Vaia windstorm hit the eastern Italian Alps, toppling an estimated 40 million trees across 41,000 hectares. We investigated how such catastrophic disturbance influenced small mammal community composition, population dynamics, and tick-borne pathogens circulation. This study compared Vaia windthrows and undisturbed forests across two distinct altitudinal levels in the Paneveggio-Pale di San Martino Natural Park (Trento, Italy) from 2022 to 2025.

We live-trapped small mammals, assessed tick burden on rodent hosts, collected and analyzed microorganisms in questing ticks from the vegetation. Sites affected by the windstorm had a higher small mammal species richness (including open habitat species such as *Microtus* spp.), and abundance (of e.g. shrews and *Clethrionomys glareolus*), but their home ranges decreased. Notably, *Apodemus* spp. density was primarily driven by altitude. In total, 295 Ixodes spp. ticks were counted on the captured small mammals, with the majority (73%) in disturbed sites and on *C. glareolus*. In total 1021 *Ixodes* spp. ticks were collected; those in Vaia-disturbed habitats showed a richer and more interconnected community of microorganisms, with higher prevalence of some key pathogens such as *Borrelia burgdorferi* s.l. and *Neoehrlichia mikurensis*. Furthermore, habitat disruption appears to have increased opportunities for pathogen co-occurrence, consistent with more complex transmission pathways.

We conclude that natural reforestation following a severe climatic event creates complex and heterogeneous habitats that modulate small mammal dynamics, promoting host-parasite encounters and potentially enhancing zoonotic pathogen circulation during this transitional recovery phase, before the ecosystem returns to a mature climax forest state.

Keywords: Extreme weather events, Small mammals, Ticks, Tick-borne pathogens, Habitat

OP 4.8 - Windstorm impacts on mountain forests: a multi-taxa assessment of the Vaia event on mammal communities and forest dynamics in the Altopiano di Piné, Trentino

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While abiotic disturbances are major drivers of forest biodiversity, climate change is intensifying their frequency and severity. In October 2018, the Vaia windstorm caused extensive forest damage, potentially altering forest dynamics, wildlife–forest interactions, and related ecosystem services. In 2025, we studied the effects of Vaia on mammal communities, woody vegetation, and wildlife–forest interactions across a gradient of storm impact (low, medium, high) in the Altopiano di Piné (Trento, Italy). We combined live-trapping and camera-trapping with vegetation surveys. We deployed 54 camera traps following a systematic grid with random placement. Thirty of these cameras were paired with 100-m live-trapping transects, while vegetation surveys were conducted at all sampling sites.

Camera-trap detections showed significantly lower species richness in highly impacted sites, and most species showed reduced detections and captures in highly impacted areas, except for a few species associated with open habitats. Vegetation surveys revealed increased shrub cover and higher woody species richness in impacted sites, driven by canopy opening. These structural and compositional changes create a more heterogeneous environment, influencing mammal habitat use. Further analyses will investigate wildlife effects on regeneration and forest functional diversity under contrasting impact levels, with implications for ecosystem resilience and carbon storage.

Keywords: Windstorm disturbance, Mammal communities, Forest dynamics, Wildlife–forest interactions

OP 4.9 - The conservation value of disproportionately consequential individuals: Individual variation shapes the dispersal of ecological interactions in Alpine forests

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As conservation biologists, we often focus on species-level patterns while overlooking the role of individual variation in shaping ecosystem processes. Here, we show how some individuals with particular behavioral traits can disproportionately influence the functioning and resilience of Alpine forest ecosystems by affecting the dispersal of key ecological interactions. Small scatter-hoarding rodents play a critical role in mountain forests by moving both tree seeds and their associated mycorrhizal fungi, potentially facilitating tree regeneration and range shifts under climate change.

We conducted a series of field experiments in the Prealpi Giulie Natural Park (North-Eastern Italy), an Alpine biodiversity hotspot, combining behavioral phenotyping of 216 rodents with measurements of multiple stages of the dispersal process. We examined how individual traits influence seed selection, caching decisions, truffle detection, fungal spore transport, spore viability, and the establishment of mycorrhizal associations in oak seedlings.

Across these experiments, we found that individual differences among rodents strongly affected the effectiveness of seed and fungal dispersal, with some individuals contributing disproportionately to the movement of plant–fungus interactions across landscapes.
These findings highlight the importance of conserving behavioral diversity within Alpine wildlife populations to maintain ecosystem functioning and resilience under global change.

Keywords: Small mammals, Seed dispersal, Personality, Phenotypes, Forest regeneration

OP 4.10 - Influence of forest compositional naturalness on climate change vulnerability and disturbance risks in Alpine mountain landscapes

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European Alpine forests have been strongly shaped by past human activities, which altered their structure and tree-species composition. Assessing how closely current forests match their potential natural composition is important for evaluating biodiversity potential and informing management. However, it remains unclear whether forests with higher compositional naturalness are also less vulnerable to climate change and natural disturbances. Using the process-based landscape model iLand, we assessed forest compositional naturalness and disturbance vulnerability across a large mountain landscape in South Tyrol, Italy. We developed a spatially explicit index comparing current and potential tree-species composition and simulated future forest dynamics under multiple climate and disturbance scenarios, focusing on wind and bark beetle. We compared two alternative initial vegetation conditions on the same landscape:
current forest and potential forest.

Current forests showed generally low naturalness, reflecting historical management, with low values at low and high elevations and medium to high values at mid elevations. Vulnerability patterns differed between vegetation conditions. Current forests were more susceptible to bark beetle outbreaks, largely due to the historical promotion of Norway spruce and its increasing sensitivity under warming. In contrast, potential forests were more vulnerable to wind disturbance, likely because old-growth features such as greater height heterogeneity and canopy roughness increased blowdown risk. These findings show that higher naturalness does not necessarily imply greater resilience to climate-induced disturbances and highlight the importance of balancing structural and compositional heterogeneity in future management.

Keywords: Forest modelling, Natural disturbances, Climate change, Italian Alps, Tree species composition

OP 4.11 - Urbanisation reshapes bat communities through environmental filtering and homogenisation in mountain landscapes

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Mountain ecosystems support high biodiversity yet are increasingly reshaped by interacting global change drivers, highlighting the need to understand how urbanisation influences biodiversity patterns across mountain landscapes. Using 59,247 bat passes recorded at 70 sites spanning seven major land-use types, from forests to cities across South Tyrol (Italian Alps), we assessed how urbanisation shapes bat community composition and the environmental filters underlying diversity patterns. While elevation had little influence on bat diversity and community composition, land use emerged as the primary driver of community structure, highlighting anthropogenic disturbance below the treeline.

Urban bat communities were dominated by synanthropic *Pipistrellus* species and exhibited reduced β-diversity, indicating increasing homogenisation across urban land-use types. However, village communities supported a broader species pool, retaining both urban-tolerant and urban-sensitive species/groups, including *Myotis*, *Plecotus* and *Rhinolophus*, whereas forests harboured distinct assemblages associated with light-sensitive and forest-specialist species/groups. Within settlements, woody vegetation increased bat activity and foraging activity, while artificial light at night emerged as the dominant environmental filter favouring urban-tolerant species/groups over light-sensitive ones.

At the landscape scale, bat activity within settlements increased with forest proximity but declined with increasing numbers of surrounding forest patches. Together, our findings demonstrate that anthropogenic disturbance restructures bat community composition through environmental filtering and biotic homogenisation, while villages function as ecotonal refugia maintaining both disturbance-tolerant and disturbance-sensitive species/groups. These findings highlight the importance of considering community composition alongside species richness when assessing biodiversity responses to global change.

Keywords: Acoustic monitoring, Biodiversity assessment, Long-term monitoring, Community composition, Chiroptera

OP 4.12 - Partitioning human and brown bear niches: Interactive effects of biological and social drivers on movement corridors in the Alpine Region

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Large carnivore movement is constrained not only by infrastructure, but by “social carrying capacity.” Although biological suitability in the Alps is documented, acceptance may act as an invisible resistance layer, rerouting dispersal and suppressing realized range. Yet acceptance is rarely integrated into connectivity models. We address this gap by combining spatiotemporal social and bear occurrence data to quantify realized resistance.

25 years after brown bear (*Ursus arctos*) reintroduction to the Central Alps, the population has grown (2023: N=98 [86–120]), yet range expansion remains limited and connectivity with the Alpine-Dinaric metapopulation has not emerged. Human-caused mortality comprises a major share of adult deaths, suggesting social constraints may limit connectivity before ecological capacity is reached. We analyze a rare longitudinal acceptance dataset collected before and after reintroduction (-2, +1, and +22 years; n=1200–2000). Mean tolerance dropped post-reintroduction (-1.23 SDs from 2003 to 2024), though spatial polarization relative to bear density was weaker than expected ($\varphi \approx 0.23$ [0.03–0.60]). Predictive power on tolerance inverted between demographics and perceptions before versus after reintroduction. We integrate acceptance, biophysical, recreation/mobility, and multi-source bear presence data using Bayesian Additive Regression Trees to estimate resistance, and model corridors with circuit theory.

Keywords: Bear, Suitability, Reintroduction, Tolerance, Movement

OP 4.13 - Recovering in isolation: Dynamics of an isolated brown bear population over two decades post-reintroduction

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Large carnivores have been extirpated from much of their historical range, but conservation efforts have supported their recovery. The brown bear reintroduction in the central Alps represents one such case, yet long-term viability of this population remains uncertain due to its small size, isolation, and increasing conflicts with humans. Using spatial capture-recapture and survival models based on non-invasive genetic data and known bear deaths collected on 222 individuals over 21 years (2003–2023), we assessed spatio-temporal trends in bear density, abundance, survival, and range expansion, accounting for sex and age-specific differences. Results indicate an annual density growth rate of 7.7%, with a mean density of 1.6 bears/100 km2 in the whole study area in 2023, rising to 2.5 within the area permanently occupied by females.

Survival probabilities varied by sex and age, with females showing strong site fidelity and males exhibiting higher dispersal and mortality. Although an ecological barrier hinders eastward expansion and connectivity, the permanent range of females increased by 137%. Despite growth, the population remains small and vulnerable to stochastic events. Sustained genetic monitoring, improved connectivity, and science-based management will be crucial to balance conservation goals and social concerns, ensuring the persistence of this population in a human-dominated landscape.

Keywords: Spatial capture-recapture, Large carnivore reintroduction, Survival analysis, Genetic monitoring, Human-wildlife conflicts

OP 4.14 - Integrating movement ecology and zoogeochemistry to quantify the role of large herbivores in multi-scale alpine ecosystem resilience

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Large herbivores function as vital macro-ecological vectors driving biogeochemical cycles within dynamic ecosystems. However, traditional zoogeochemical models often overlook how animal movement modulates nutrient flows and landscape stability. We address this gap using an Agent-Based Model (ABM) that integrates movement ecology with landscape-scale nitrogen (N) dynamics in the Italian Alps. By coupling high-resolution GPS trajectories of red deer (Cervus elaphus) with spatial land-use and environmental data, we simulate how daily movement, as well as the maintenance or loss of animal migration, shapes nitrogen redistribution.

Our analysis reveals that red deer function as critical vectors driving nitrogen flux across multiple scales: localized foraging transfers nitrogen from grasslands to forest patches, while landscape-level migration facilitates altitudinal and slope-gradient fluxes that can help buffer ecosystems against extreme variations. Conversely, anthropogenic barriers disrupt these historical flows, concentrating nutrients and threatening localized ecosystem resistance. Notably, these non-linear nutrient pathways represent a critical point in systemic connectivity, potentially bridging macro-ecological biodiversity with microscopic soil biodiversity and biogeochemical networks. Our work shows that preserving macro-scale migration can help maintain the stability, resistance, and health resilience of alpine ecosystems under escalating human-altered pressures.

Keywords: Animal ecology, Biogeochemistry, Ecosystem ecology, Movement ecology, Nitrogen

OP 4.15 - Bridging landscape planning and biodiversity conservation: A case study on amphibian communities of the Province of Trento (Italy)

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In the last few centuries, about 80% of European wetlands have been lost, and the remaining 20% are slowly deteriorating due to climate-related impacts combined with other human-mediated pressures. Thus, the rethinking of wetlands as multifunctional landscapes, and coordinated, cross-sectoral policy approaches are urgently needed. Here we present a transdisciplinary workflow aimed at bridging the gaps between conservation biology and landscape planning disciplines. As a case study, amphibian presence data from an environmental DNA-based survey of 37 water bodies (Province of Trento, Italy), including both protected areas and artificial or human-impacted basins, were used to investigate the relationship between species richness, habitat quality, anthropogenic impact, and climate change by means of multidimensional correspondence and regression analyses.

This innovative approach allowed us to identify distinct ecological and territorial profiles, shaped by the interaction between amphibian communities and environmental conditions. Beyond providing an informative basis for understanding species dynamics in relation to environmental disturbance, this approach offers operational support for activities such as Natura 2000 site management, and Environmental Impact Assessment. This workflow is highly replicable in comparable mountain contexts, with applications in endangered species monitoring, environmental and landscape management, urban ecology, and policy development.

Keywords: Wetlands, Conservation biology, Landscape planning, Amphibians, eDNA

OP 4.16 - Multi-scale connectivity of Alpine pasture microbiotas along an elevational gradient

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Alpine pastures are a complex and multidimensional habitat in which animals and plants interact with each other and with diverse soil-borne bacteria and fungi ('microbiota'), forming an ecological network that extends both above ground and within the soil. Although host-associated microorganisms are essential to plant and animal health and adaptive potential, they are overwhelmingly understudied in non-model species, and their interactions with soil remain poorly understood. In addition, the extent to which climate change will impact Alpine pasture micro-biodiversity is still entirely unknown. Here, we investigated changes in bacterial and fungal diversity using metataxonomy on more than 900 field samples of soil, rhizosphere soil, whole invertebrates and vertebrate feces along an elevational gradient spanning 1500 meters used as a proxy for climate change.

We found that soil, plant and animal microbiota were characterized by distinct but partially overlapping microbial communities, with diversity and composition shaped by both biotic and abiotic factors. Animal bacterial microbiota was markedly shaped by host-interaction dynamics, while fungal communities showed closer associations with habitat and elevation. Compositional overlaps between microbial communities were greater between soil, rhizosphere, and soil-dwelling invertebrates, compared to other invertebrates and vertebrate fecal samples, highlighting above/belowground and host/habitat-specific associations in the Alpine metacommunity.

Keywords: Alpine pasture, Global warming, Metataxonomy, Microbiota, Metacommunity

OP 4.17 - Biocultural refugia in a changing world: First ecological evidence from traditional chestnut orchards in the Italian Alps

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Traditional chestnut orchards (*Castanea sativa* Mill.) are biocultural systems in which biodiversity, cultural heritage, and long-term management practices have co-evolved over centuries.
Today, these semi-natural habitats face increasing pressures from climate change, emerging phytosanitary threats, and socio-economic transformations affecting their management and persistence. This contribution presents the first ecological results from an ongoing interdisciplinary project investigating change in traditional chestnut orchards across northern Italy (Trentino and Emilia-Romagna). The project integrates three dimensions of change: ecological and climatic dynamics, local stakeholders' perceptions, and management practices. Sixty actively managed historical orchards were selected, characterized by centennial trees and long-term continuity.

We focus on the first field season in Trentino, combining botanical and phytopathological surveys with structured interviews involving chestnut growers, forest managers, technicians, and public authorities. Preliminary results confirm their role as biodiversity reservoirs and distinctive biocultural landscapes, and the classification of "*Castanea sativa* old established plantations" as Natura 2000 habitat type "9260," as provided for in the European interpretive manual, although this is not always accepted at the local level. By linking ecological evidence with stakeholder knowledge and governance practices, the project enhances understanding of the multiple values of chestnut orchards beyond fruit production, including biodiversity conservation, ecosystem services, cultural heritage, and landscape resilience.

Keywords: Chestnut orchards, Biocultural landscapes, Traditional agroecosystems, Local Ecological Knowledge (LEK), Extensive land management

OP 4.18 - Chestnut blight reshapes bark-associated bacterial communities in European chestnut

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The sweet chestnut (*Castanea sativa*) is threatened by multiple diseases, including chestnut blight, caused by the fungus *Cryphonectria parasitica*, which affects the bark of infected trees.
The composition of bark-associated bacterial communities may thus be shaped not only by host-related factors, but also by biotic interactions, including colonization by pathogens.

However, the role of the microbial community associated with chestnut blight cankers in disease development remains poorly understood, and its impact on the severity of chestnut blight cankers is still largely unknown. In this study, we investigated the composition of the bacterial communities associated with chestnut blight, using a culture-independent metabarcoding approach based on the analysis of an amplicon library targeting the bacterial V5–V7 region of the 16S rRNA gene, via Illumina high-throughput sequencing. Inner bark tissue comprising the cambium and phloem, were collected from healthy portions of sweet chestnut trees and from active virulent and hypovirulent cankers in five managed Marrone chestnut stands in the San Zeno di Montagna area, Lake Garda, northern Italy.

Significant differences in bacterial community composition were observed among healthy and diseased bark tissues. Beta-diversity analysis of the 50 most abundant genera revealed distinct clustering of healthy, hypovirulent, and virulent samples, indicating differences in overall microbial community structure. Furthermore, the bacterial communities associated with hypovirulent infections were more closely related to those of healthy tissues than to those of virulent infections. These findings provide the first characterization of bacterial diversity associated with virulent and hypovirulent chestnut blight cankers in comparison with healthy chestnut bark tissue, offering a first step toward understanding microbiome dynamics that may inform future disease management strategies.

Keywords: *Castanea sativa, Cryphonectria parasitica,* Chestnut blight, Microbiome, Bacterial communities

OP 4.19 - Revitalizing traditional orchard meadows as a Nature-based Solution under global change

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Traditional agroforestry systems (TAS) are land-use systems that typically combine trees and understory management, and are designed to provide multiple ecosystem services, ranging from food and fodder production to habitat conservation and aesthetic value. Within the Euregio, Alpine Orchard Meadows (Streuobstwiesen) for example, have sustained rural livelihoods for decades, becoming integral part of the cultural identity, also contributing to ecological connectivity, genetic preservation, and diversification in agri-environments.

Due to rapid socio-economic shifts, these systems have undergone a decline as a result of the expansion of intensive farming practices, urbanization, and land abandonment. In this contribution, we present the conceptual framework developed for the EU Biodiversa+ project TRANSFOrm, which explores the potential of reframing traditional systems from static elements of cultural heritage into adaptive Nature-based Solution (NbS) that support climate change adaptation, biodiversity preservation, and rural livelihoods. Building upon a harmonized framework across six countries (IT, LT, PT, ES, AT, IS), this work focuses on South Tyrolean case study, where multi-taxa monitoring and stakeholder involvement are employed to quantify key bundles of ecosystem services and their trade-offs and synergies across NbS scenarios. The results will contribute to a better understanding of TAS, informing decision-making processes aimed at their restoration and resilience.

Keywords: Orchard meadows, Nature-based Solution, Restoration, South Tyrol, Ecosystem Services

OP 4.20 - Ants as bioindicators: Feasibility and ecological value in multi-taxon biodiversity monitoring of Alpine forests

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Biodiversity monitoring programs typically focus on well-known, widespread, and easily sampled taxa as bioindicators, while their ability to represent overall biodiversity is rarely evaluated.
Ants are ubiquitous taxa in terrestrial ecosystems but are keystone species for ecosystem functioning. Despite this, they remain largely underrepresented in monitoring schemes due to sampling and identification challenges. Yet, their ecological importance and long-lived, site-bound colonies make them promising bioindicators.

In this study, we assessed ant communities across forest sites included in the Biodiversity Monitoring South Tyrol program, spanning an elevational gradient of 1900m and encompassing multiple forest types. We combined standardised sampling methods (pitfall traps, soil cores, litter samples), which can be carried out by non-specialists, with targeted hand sampling conducted by expert myrmecologists. We then compared ant community metrics with other monitored taxa (such as plants, birds and butterflies) and with forest microhabitat diversity.

We found significant correlations between the ant communities and indices of other taxonomic groups, supporting that ants are a valuable addition in biodiversity monitoring programs.
This study highlights both the feasibility and the ecological added value of including ants in multitaxon biodiversity monitoring programs and contributes to a better understanding of their potential role in forest ecosystems.

Keywords: Biodiversity monitoring, Forest entomology, Myrmecology

OP 4.21 - Heterogeneous orchard configurations support abundant breeding bird populations and diverse communities in intensive apple orchards

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Agricultural intensification has so far threatened biodiversity and ecosystem functioning, whose services ensure current and future food production. Fruit orchards are witnessing such intensification through structural and landscape simplification, increased chemical inputs, and mechanised management. Here, we investigated how birds responded to intensive apple orchards in the Non Valley, northern Italy. We carried out a two-level analysis, on the abundances of ten orchard-nesting species and on the richness/diversity of the whole orchard-dwelling avian community.

We found that intensive apple orchards hosted a simplified community, dominated by generalist woodland species (mainly Turdidae and Fringillidae). The most intensified conditions (i.e., higher tree density and orchard cover) increased orchard-nesting species abundances but decreased community metrics, while landscape heterogeneity had positive effects on the community but not on the single species. Notably, spatial heterogeneity in orchard age simultaneously favoured both levels, hosting more abundant orchard-nesting populations and more diverse avian communities.

This heterogeneity in orchard configuration may provide a win-win solution for crop renewal, bird conservation, and the potential delivery of bird-mediated ecosystem services (namely pest/weed control and recreation). We therefore suggest future orchard renewals to programmatically retain older stands within renewed ones, enhancing heterogeneous configurations and a more sustainable apple production.

Keywords: Agroecology, Intensive agriculture, Birds, Apple orchards, Meta-regression analysis

OP 4.22 - Threatened yet adaptable: Phenotypic plasticity in red wood ants along altitudinal gradients

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Red wood ants (*Formica rufa* species group) are Holarctic keystone and umbrella species that provide essential ecological functions in forests and grasslands. They build large mound-shaped nests and typically dominate their habitat. However, anthropogenic impacts and climate change appear to negatively affect their populations, and little is known about their capacity to respond to these pressures. A few studies showed evidence of phenotypic and behavioural adaptability along gradients and in human-altered populations.

The aim of this study was to investigate phenotypic plasticity in red wood ants across elevational gradients. We sampled nest material and individuals along five elevation gradients, covering more than 100 nests in South Tyrol (Italy). We assessed three traits: cuticular coloration (image analysis), nest material selection and heterogeneity (particle size measurements), and trophic position (stable isotope analysis of nitrogen and carbon).

We found evidence of potential adaptive plasticity in trophic position, coloration intensity, and nest material selection, suggesting a partial capacity of red wood ants to adjust to environmental variation. These findings provide new insights into their responses to environmental change and can inform conservation strategies and predictions on the future functioning of forest ecosystems.

Keywords: *Formica rufa* species group, Environmental variation, Cuticular coloration, Stable isotopes, Trophic ecology

OP 4.23 - Management, topography and landscape contribute to shape avian communities in Alpine semi-natural grasslands and fine-scale habitat selection of declining species

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Grasslands are key habitats for biodiversity but are declining and degrading due to abandonment, conversion and intensification. Many grassland specialists have declined; some found refuges in mountain grasslands but are now threatened by land-use and climate changes. We assessed the link between grassland breeding bird communities (species richness and abundance of functional groups), and landscape/topography/management in 166 transects in the Italian Alps, along environmental and management gradients. All types of predictors contributed to shaping avian communities, but with varying importance. The most relevant management variable was (intensive) valley-floor grasslands, influencing negatively insectivores, and positively granivorous and pest species. Among subsidies related to the CAP, only late mowing (10.1.1) and organic management entered few models with positive effects. Landscape features were the most frequent predictors.

Broadleaved forests influenced positively vegetation-dwelling insectivores, and negatively grassland species. Apple orchards negatively influenced species richness and insectivores.
Alpine grasslands affected positively grassland birds. Finally, the number of grassland species and grassland-dwelling insectivores increased with elevation. We further assessed fine-scale (1-ha) habitat requirements of the red-backed shrike. Shrublands and hedgerows were key predictors of breeding territory selection, while woodlands and anthropogenic settlements were avoided. Red-backed shrike selected habitats with higher Shannon NDVI and preferred moderately sloping areas, avoiding grasslands at intermediate elevations. These results highlight the urgent need to revise agricultural subsidies to promote biodiversity-oriented management, preserve low-intensity grasslands, and integrate species-specific habitat requirements into agri-environmental and landscape planning policies to halt biodiversity loss in alpine agroecosystems.

Keywords: Agricultural intensification, Grassland ecology, Functional guilds, Breeding birds, Conservation

OP 4.24 - Genomic structure and diversity of European beech highlight contrasting demographic histories across the Italian Peninsula

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Understanding patterns of genomic diversity is central to defining conservation units and predicting species resilience. We integrated 132 newly sequenced individuals from eight Italian stands with 874 published genomes (total n = 1,006) to resolve the genetic structure of European beech (*Fagus sylvatica*), which lacked the Italian Peninsula. PCA and admixture analyses revealed that North Italian stands share their ancestry with the Northern-Dinaric gene pool, whereas South Italian populations represent a highly differentiated genetic lineage. The analysis on genetic diversity shows that the Trentino-Alto Adige stands display a higher fraction of runs of homozygosity (FROH) compared to southern populations like Sicily and Matese, and even the lowest observed heterozygosity Europe-wide, except for Spain. Correspondingly, the Trentino-Alto Adige stands show lower contemporary effective population size (Ne) estimates relative to southern cohorts, although from historical Ne estimates the Sicilian population seems to have undergone a contraction.

These patterns might indicate stronger founder effects or localized bottlenecks during postglacial recolonization in northern Italy, contrasting with the large refugia maintained in the south.
These insights highlight the contrasting regional demographic histories within the Italian Peninsula, providing a vital baseline to inform targeted conservation and forest management strategies under ongoing climate change.

Keywords: *Fagus sylvatica*, Population genomics, Demographic history, Effective population size, Conservation genetics

OP 4.25 - Habitat restoration as part of the LIFE SeedForce project

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Habitat restoration plays a key role within the Life SeedForce project. SeedForce focuses 29 policy species reported in bad conservation status in Europe according to the EU Habitat Directive, aiming at reversing the current unfavourable conditions. The target species will benefit from habitat improvement and propagation and translocation activities, designed to counteract both external habitat-related threats and intrinsic species-related issues.

In Trentino, the target species are mostly associated with secondary habitats, which have so far been maintained through traditional management practices. Thus, the main threats to habitat conservation here involve discontinued practice of haymaking and wood clearing leading to woodland expansion and increased shading. Preliminary habitat management at the target sites aimed to reverse this trend, with the vegetation being cleared and subsequently removed.
This intervention was sufficient to enable *G. palustris* to resprout at a site where it had not been recorded for years. In some cases, it has been essential to raise awareness among private landowners on the correct period for haymaking, to allow the species to complete the reproductive cycle. All these measures ensure that the reintroductions and population reinforcement activities envisaged in the project have a long-term effect.

Keywords: Biodiversity conservation, Habitat restoration, Secondary habitat management, SeedForce project

OP 4.26 - Airborne pollen trends over three decades in Bolzano (South Tyrol): Long term changes in seasonality and abundance

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Airborne pollen represents a significant societal burden due to its allergenic effects, and its long-term dynamics are increasingly shaped by climate change and anthropogenic alterations of vegetation. Understanding these changes is essential for assessing biodiversity responses and supporting climate-adaptive management and conservation strategies. In this study we investigated long-term trends in airborne pollen in the urban area of Bolzano (South Tyrol) over a 30-year period (1995–2024), focusing on shifts in taxonomic composition, pollen abundance, and phenological characteristics of the main pollen season.

Pollen data were collected in the continuous aerobiological monitoring program of the Agency for Environment and Climate Protection using a Hirst-type volumetric sampler and analyzed following European standard protocols. Thirty-one dominant taxa were evaluated. Long-term changes were quantified using generalized linear models to estimate relative annual changes in the Annual Pollen Integral (ΔAPIn), complemented by analyses of main pollen season descriptors, timing, duration and total amount of airborne pollen recorded over an entire year for a given taxon.

The total annual pollen integral (APIn) was dominated by arboreal taxa, which exhibited a marked increase over time, particularly among highly allergenic and partly non-native species such as *Morus*, Cupressaceae and *Olea*. In contrast, non-arboreal taxa showed no increases, with several native groups (Poaceae, Urticaceae, native *Artemisia* species) displaying stable or declining trends. Phenological shifts, including earlier onset and prolonged pollen seasons, were observed for several taxa, especially Poaceae and Urticaceae.

Keywords: Pollen, Long terms trends, Pollen monitoring, Aerobiology

OP 4.27 - Effects of non-native species on riparian forest communities

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Biological invasions are a major driver of global change, affecting the functioning of natural ecosystems. Invasive climbing plants, particularly lianas, can strongly alter forest structure and composition by competing with native vegetation, although their effects across different forest layers have rarely been investigated. Using 122 paired plots (invaded vs. non-invaded), we investigated along the second longest river in Italy (410 km, northeastern Italy) how four non-native liana taxa (*Humulus scandens, Parthenocissus quinquefolia* group, *Sicyos angulatus*, *Vitis riparia group*) affect the taxonomic diversity (species richness and Simpson diversity), functional diversity (FD), and functional composition (community-weighted mean, CWM) of plant height and specific leaf area in riparian forest communities of the Adige River.

We found that different taxa tend to invade distinct vegetation layers. Simpson diversity was higher in invaded plots than in non-invaded plots when all layers were considered, whereas both Simpson diversity and species richness were higher in invaded plots only in the tree layer. Across layers, invaded plots showed lower FD and CWM for plant height and higher FD and CWM for specific leaf area compared to non-invaded plots. However, these responses depended on the vegetation layer considered, with the tree layer in invaded plots showing higher FD and CWM for all traits except CWM for plant height, which was lower. Similar patterns were observed in the shrub layer, although FD for plant height was lower in invaded plots.

In the herb layer, only plant height CWM was lower in invaded plots compared to non-invaded plots. However, when the dominant invasive liana was excluded from the analyses, most differences disappeared. Overall, our results demonstrate that invasive lianas can alter community structure and functional composition differently across forest layers in riparian ecosystems, with important implications for ecosystem functioning.

Keywords: Biological invasion, Alien species, Lianas, Riparian ecosystems

OP 4.28 - Assessing atmospheric pollution along urban–rural gradients in South Tyrol using bryophytes

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Atmospheric pollution is a major environmental pressure that affects biodiversity, ecosystem functioning, and human well-being. Along urban–rural gradients, pollutant loads and deposition patterns can vary considerably, reflecting differences in population density, land use, traffic intensity, and other human activities. Assessing these patterns is essential for evaluating environmental quality and understanding their ecological consequences.

The Atmospheric Purity Index (IAP) is a valuable bryological indicator for assessing environmental quality and monitoring atmospheric pollution. Within the Biodiversity Monitoring South Tyrol (BMS) project, epiphytic bryophytes are surveyed in 32 settlements across South Tyrol, with samples collected from three trees at each site. Bryophyte richness and community composition are used to calculate IAP values, providing an integrated measure of local atmospheric quality.

Beyond their traditional use as bioindicators, bryophytes also enable trait-based analyses. Functional traits, including growth form, life strategy, habitat preferences, and ecological indicator values, can help explain community responses to environmental change, particularly to nitrogen enrichment in urbanized environments.

Combining IAP assessments with functional trait analyses provides a valuable framework for evaluating the effects of atmospheric deposition and urbanization on bryophyte communities and for complementing traditional biodiversity and air-quality assessments in South Tyrol.

Keywords: Bryophytes, Atmospheric pollution, Biodiversity

OP 4.29 - Protected areas unevenly contribute to lichens conservation in the Alps

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Protected areas (PAs) are central to biodiversity conservation, yet their representativeness remains poorly quantified for neglected taxa, including lichens. Using the Dolichens database, one of the largest datasets of georeferenced lichen occurrences available for EU, we assessed the representativeness of lichen diversity across three protection categories: Strict PAs (IUCN Ia-II), Nationally Designated PAs, and Natura 2000 sites. After reducing spatial bias, species occurrences were intersected with the PAs network and evaluated against species-specific conservation targets, derived from a logistic function linking protection levels to species rarity, assigning higher protection to rare species.

Pas unevenly represent lichen diversity across protection categories. Although Natura 2000 sites provide the highest representativeness, substantial shortfalls remain for many species. These gaps are particularly pronounced in Strict PAs, where most species, including many conservation-priority taxa, fail to meet their conservation targets. Furthermore, under-represented species frequently occur far from existing PAs, revealing persistent spatial gaps in current conservation networks.

Our findings demonstrate that apparently high coverage levels can mask important representativeness deficits when species-specific conservation requirements are considered.

By identifying priority species and spatial conservation gaps, this study provides the first assessment of PAs representativeness for lichens and highlights the need to incorporate lichens into conservation planning.

Keywords: Conservation representativeness, Lichens, Alps, Protected Areas, Natura 2000

OP 4.30 - Paesaggi Forti. Imaginaries and narratives on ecologies in motion for abandoned places

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First World War left on the Alpine territory traces and structures that have profoundly modified the mountain, and only partially reabsorbed by the context over time. Over the last one hundred years, these sites have seen the superimposition of a series of new protagonists and stories, over and beyond the main historical events: these stratifications reveal the relationship between local communities and war artefacts, but also about ecological events, factors and new multispecific inhabitants. *Paesaggi Forti* aims to be an observatory on this unfolding process and an open laboratory towards a new shared imaginary. The contribution will share methods and insight on accompanying new ecologies in motion for abandoned places. Indeed, the ruins of a past war have been transformed into contemporary landscapes: hybrid, stratified and complex. The historic site slowly turned into an ecosystem, bearing a kit of new and incoming ecologies, able to cohabit these places together with shadows of memories and ghosts of disappeared wars.

Keywords: Dynamic landscapes; Geo-graphies; Traces; New ecologies; Transformations

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OP 4.31 - Responses of benthic freshwater organism, *Chironomus riparius* to regenerated and fossil PA6 produced in an Alpine region

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Alpine environments are recognised as sinks for microplastic (MP), with fibres often dominating in remote freshwater systems. Given the extensive use of nylon in technical alpine clothing, fibre-shaped MPs are widely dispersed. However, it remains unclear whether recycled materials represent safer alternatives to virgin plastics, particularly in alpine contexts where comparative studies are lacking.

We investigated the multigenerational effects of two products from an alpine-based company: fossil-based polyamide 6 (PA6) and chemically recycled polyamide 6 (Econyl®) fibres (200 µm length, 40 µm diameter), on the benthic freshwater species *Chironomus riparius* which is also common in alpine rivers and represents a suitable ecological model. Econyl® is produced via chemical de-polymerization, monomer purification and re-polymerization. Organisms were exposed for two generations to an environmentally relevant concentration (2 mg/150 g sediment d.w.), reflecting levels reported in Italian rivers. Experiments followed OECD guideline 233 and included biomarkers of oxidative damage (MDA, PCC).

Both materials induced comparable responses on emergence rate and development rate, in the first generation. In the second, PA6 showed stronger effects on emergence and development.
No significant differences were observed for biomarkers. Our results suggest that fibre regeneration may represent a viable strategy to reduce ecological risks associated with MPs.

Keywords: Regenerated nylon, Ecotoxicology, Alpine freshwater contaminant, Benthic Organism

OP 4.32 - Changes in phytoplankton species abundance distributions along environmental gradients

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Understanding how abiotic and biotic factors structure ecological communities is an ongoing challenge. Here, we use species abundance distributions (SADs) as a framework to analyze temporal changes of community structure along environmental changes. Specifically, we investigated how the SAD shape of phytoplankton communities changes along environmental gradients using long-term data from 13 alpine and peri-alpine lakes situated in the same geographical region. We used community evenness—how uniformly species abundances are distributed in a community—and skewness—which depicts species rarity-dominance patterns—as metrics to describe SADs changes.

Our analysis reveals that the shape of SADs not only reflects, but dynamically tracks changes in community structure. Our findings show that community responses to environmental changes differ across two different lake groups defined by morpho-physical and ecological characteristics. While temperature consistently increased evenness and had overall no significant effect on skewness across lake groups, nutrient enrichment promoted two contrasting phytoplankton responses: it increased evenness in one group while decreasing it in the other. Skewness increased in both lake groups, however in opposite directions. Our study demonstrates that SADs are dynamic descriptors of environmental changes and can be used to study community responses over time.

Keywords: Species abundance distribution, Community structure, Evenness, Skewness, Environmental changes

OP 4.33 - Evolutionary consequences of host plant association in *Cacopsylla melanoneura*: evidence from comparative genomics with co-generic species

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Apple proliferation (AP) is a severe disease affecting European apple cultivation and is caused by the bacterial pathogen '*Candidatus* Phytoplasma mali' ('*Ca.* P. mali'). The primary insect vectors of '*Ca.* P. mali' are the apple psyllids *Cacopsylla melanoneura* and *C. picta. C. melanoneura* is associated with both apple and hawthorn trees and, in regions where C. picta is absent, serves as the sole vector responsible for the spread of '*Ca.* P. mali' in apple orchards. Laboratory studies suggest that populations developing on apple and hawthorn differ ecologically.

The aim of this study was to identify the genetic basis of host-associated reproductive preferences in *C. melanoneura* and to define evolutionarily significant units within the species.
To achieve this, we generated a reference nuclear genome for *C. melanoneura* using a combination of long- and short-read sequencing technologies. We also sequenced genomes of closely related species within the same genus that exhibit similar reproductive host-plant associations. Using these newly assembled genomes as references, we investigated genetic variation associated with host preference in sympatric wild populations collected from apple and hawthorn trees across Europe, including Austria, Italy, Germany, the Czech Republic, Romania, and Serbia. Mitochondrial analyses indicate that *C. melanoneura* represents a species complex comprising at least two cryptic lineages, despite the absence of known morphological differences. Furthermore, nuclear SNP analyses support the existence of two genetically distinct groups associated with different host preferences throughout Europe.

These findings provide valuable insights into the genetic basis of reproductive host preferences in *C. melanoneura* and will contribute to improved monitoring and management of '*Ca.* P. mali' vectors across Europe.

Keywords: Host race, Genome, Apple proliferation, Psyllids

SPEED TALKS

ST 4.1 - Unveiling Biodiversity in Lake Garda with a focus on invasive species: from morphological observations to Metabarcoding monitoring

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Over the past century, Lake Garda has been increasingly threatened by non-indigenous species, which alter aquatic community interactions. In 2022, the first naturalized population of the quagga mussel *Dreissena bugensis* in Italy was documented in Lake Garda. Field surveys across twelve stations revealed that *D. bugensis* rapidly surpassed the established *D. polymorpha*, expanding from littoral to profundal zones. To build upon these findings and capture a broader picture especially of benthic biodiversity, we implemented an environmental DNA metabarcoding approach by sampling water and sediment across eight major harbors around the lake, hotspots for potential new introductions. Indeed, while traditional morphological monitoring typically detects invasive species only after their populations are well-established, advanced molecular tools can potentially assess alien species presence at earlier stages of colonization.

Preliminary molecular data based on both COI and 18S rRNA genes successfully characterized the wider communities, revealing a highly diverse composition of lake biota and detecting the presence of several species including alien and endemic, not yet documented. The integration of morphological and molecular approaches allows us to bridge the gap from organismal detection to ecosystem-wide monitoring, leading to a deeper understanding of freshwater biodiversity and the early detection of alien species.

Keywords: Lake Garda, eDNA, Alien species, Community composition, Monitoring

ST 4.2 - Seed yield of propagated native meadow species for regional seed mixtures in South Tyrol

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In the Regional Seed Project, the seeds and fruits of perennial forbs from species-rich extensively managed meadows were collected, dried, cleaned, and stored under controlled conditions. So far, propagation experience of 23 species has been gained. Depending on the species, the number of transplanted seedlings strongly differed from 1 to 2.700 individuals, with a total amount of 6.500 plants. After four seasons, conclusions can be drawn regarding the productivity: Yield per species varied widely, ranging from 0.15 to 234.93 g/m², and similarly from 0.0135 to 21.144 g/plant.
The use of regional seeds is expected to enhance functional biodiversity in agricultural.

Keywords: Regional seed production, Perennial forbs

ST 4.3 - Assessing meadow quality in Ledro Valley (Trentino) via carabid beetle functional traits

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Carabid beetles are widely employed as bioindicators because of their sensitivity to habitat disturbance and their well-known ecology. We investigated carabid communities to assess the environmental quality of seven hay meadows in the Ledro Valley (Trentino), selected on a gradient of habitat disturbance based on vegetation community analysis. We surveyed each meadow using 5 pitfall traps. Overall, we collected 2154 carabids, all identified at the species level. Environmental quality of the meadows was evaluated on the base of carabid species functional traits, such as size, diet and dispersal ability, which allowed to measure the relative stability of the communities.

Keywords: Carabid beetles, Bioindicators, Environmental quality, Agroecosystem, Agroecology

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ST 4.4 - Orthopterans in colour, assessing variation in community colour traits

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In insects, coloration is a fundamental functional trait affecting the ability to warm, defending against parasites and predators, or surviving in highly exposed habitats. With 365 species recorded in Italy, orthopterans form a substantial component of national insect biodiversity.
Many species play important ecological roles as herbivores and as prey for insectivorous vertebrates, while colouration is highly variable both within and among species. In Orthoptera, coloration potentially reflects a combination of genetic control, environmental influence and phenotypic plasticity. Quantifying this variation is a necessary first step toward understanding the effect of climatic pressure, mediated by season length changes and temperature changes, on populations of this insect group.

This study aims to investigate the relationship between local climatic conditions and the coloration of Orthoptera. During the summer of 2026, we will survey 64 sites within the Biodiversity Monitoring South Tyrol project, led by Eurac Research. To quantify coloration, we will analyse photographs of individuals taken in the field through a non-invasive, non-lethal approach and using ImageJ. We expect to find correlations between Orthoptera coloration and local environmental conditions. These findings can provide insight into potential responses to ongoing climate change and may help future conservation strategies.

Keywords: Orthoptera, Trait, Biodiversity, Alpine ecosystems, Colour

ST 4.5 - *Ambrosia artemisiifolia* dispersion and its threat to biodiversity: A pollen analysis approach.

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Pollen monitoring effectively tracks invasive species like *Ambrosia artemisiifolia*, a highly allergenic North American plant threatening agricultural and natural biodiversity. In Northern Italy, Ambrosia is widespread from the Po Valley to the Alpine region, with pollen recorded in Trentino since 1992. While climate change accelerates its expansion toward higher elevations and northern latitudes, the accidental introduction of the biocontrol agent *Ophraella communa* has significantly reduced plant populations and pollen production in the Po valley. To evaluate *Ambrosia*'s future evolution in Alpine ecosystems, aerobiological monitoring and the complex interrelations with climatic drivers and the biocontrol agent remain essential.

Keywords: Ragweed, Invasive species, Allergy, Airborne pollen

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ST 4.6 - Bridging biodiversity monitoring gaps in the European Alps to support evidence-based conservation for pollinators, birds and mammals

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Mountain ecosystems are biodiversity-rich systems exposed to climate and land-use change.
As a result, long-term biodiversity monitoring is crucial to quantify ecological responses, particularly in the European Alps, a major biodiversity hotspot hosting many species with narrow climatic niches. Yet, monitoring remains fragmented across countries, taxa, and elevations, limiting Alpine-wide assessments of biodiversity change. Here, we report the results of three online surveys of long-term biodiversity monitoring programs across the European Alps, obtaining 118, 134, and 137 listed projects for pollinators, birds, and mammals, respectively.
Monitoring priorities varied among taxa, with birds' and mammals' programs showing the strongest commitment to long-term implementation.

Sampling efforts were unevenly distributed and constrained by funding, logistics, and field accessibility, influencing both spatial coverage and temporal continuity. Most monitoring sites were located below 2,500 m a.s.l., leaving higher-elevation habitats underrepresented.
Across taxa, long-term monitoring primarily aimed to assess population trends and distributions, rather than genetics and phenology. However, methodological differences in sampling protocols within and between taxa and species limit Alpine-wide trend analyses and comparisons.
Our findings indicate critical gaps in biodiversity monitoring across the Alps, with climate-vulnerable high-elevation habitats remaining underrepresented, highlighting the need for improved harmonization and transnational collaboration to support evidence-based conservation policies.

Keywords: Long-term monitoring, European Alps, Mammalia, Aves, Pollinators

ST 4.7 - Ski slope management reshapes soil quality and pedofauna composition without reducing taxonomic richness

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Current land use change can erode natural alpine soils, yet the effects of ski slopes on pedofaunal biodiversity remain often overlooked. Here, we collected soil samples from paired plots inside and outside a ski slope to assess the impacts of its management on these aspects in an alpine grassland of South Tyrol (Italy). In the ski slope, we expect reduced α- and β-diversity of pedofauna and altered chemical and physical soil properties. Soils within the ski slope indeed exhibited significantly lower total organic carbon and nitrogen, C:N ratio, and lower water-stable aggregates, alongside higher pH, possibly indicating soil degradation. Taxonomic richness did not differ between treatments; nonetheless, community composition differed markedly, with soil-fauna assemblages inside the slope being more homogeneous.

Taxonomic patterns suggested a shift towards disturbance-tolerant taxa and a decline in groups associated with stable soil conditions. Overall, ski slopes alter both chemical-physical properties and biological communities, even when species richness is maintained. These results highlight the need for sustainable management strategies to preserve belowground biodiversity around ski slope areas.

Keywords: Pedofauna, Biodiversity, Soil properties, Ski slopes

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ST 4.8 - Resort life: How winter tourism impacts mountain ungulate behaviour in the Italian Alps

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Winter outdoor recreation has expanded substantially, placing growing pressure on mountain ungulates. While responses to summer recreation are well documented, their responses to winter recreation remain poorly understood. We addressed the potential impact of a ski resort (Val di Peio, Italy) on mountain ungulate behaviour and demographics, combining camera trapping, ecoacoustics and high-resolution human disturbance data.

Preliminary results from the first season of data collection show localised spatiotemporal avoidance during peak disturbance hours. Ungulates may tolerate these disturbances to exploit favourable, south-facing overwintering habitats. We discuss further directions of investigation, such as a comparative study with an undisturbed control area.

Keywords: Ungulates, Camera trappping, Eco-acoustics, Winter ecology & outdoor recreation

ST 4.9 - Parasites at the edge: first records of Laboulbeniales (Ascomycota) from glacial and proglacial environments

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Glaciers and their forelands host diverse communities of interacting species, though host-parasite relationships involving fungi remain understudied. Here, we document the first records of Laboulbeniales (Ascomycota), obligate ectoparasitic microfungi of arthropods, from glacial and proglacial environments. Our 2025 campaign at Vedretta d'Amola Glacier (Italian Alps) revealed that 20.4% of 849 adult ground beetles carried *Laboulbeniales thalli*. Infection was strikingly host-specific, with two cold-adapted and endemic *Nebria* species affected: *N. soror* (79.8%) and *N. castanea* (20.5%). All *N. soror* from the glacier surface were infected, suggesting Laboulbeniales may represent an additional threat to those cryophilous species already facing habitat loss.

Keywords: Fungi, Carabids, Glaciers, Parasitism, Conservation

ST 4.10 - A good neighbourly relationship? Interactions between livestock and wild ungulates in an Alpine agroecosystem

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Mountain livestock farming is a fairly widespread human activity that shape agroecosystems at a local level, with effects on wild species that it is important to assess in order to promote the coexistence of domestic and wild animals within the same area. In this context, we present a new research project that aims to study, in an area of eastern Trentino, the effects of an intensive/extensive livestock farming system on the presence and activity patterns of wild ungulates. We will also discuss future prospects for extending this research to other key components of these Alpine agroecosystems.

Keywords: Livestock, Mountain Farming, Alpine Ungulates, Camera Trapping

ST 4.11 - Population genomics of the woolly apple aphid (*Eriosoma lanigerum*)

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Molecular studies have highlighted the importance of genetic diversity for species adaptation. However, some species remain poorly characterized from such standpoint, even when they are severe agricultural pests. We focused on the woolly apple aphid (*Eriosoma lanigerum*), a notorious pest of apple orchards, which currently lacks population genomics studies. We will apply genomic approaches to investigate the invasion history of *E. lanigerum* in Europe. These data will help identify the origin of non-American populations and clarify whether genomic variations are associated with ecological differences (e.g., temperature differences).

Keywords: Phylogenomics, Invasive alien species, *Malus domestica*

ST 4.12 - Impact of two cover crops mixtures on soil taxonomic diversity and functionality in alpine apple orchards

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Cover cropping can improve biodiversity in alpine agricultural systems by increasing plant diversity, soil biological activity and providing habitat for beneficial (micro)organisms. This study compares legume-dominated, grass-dominated, and spontaneous vegetation cover across five alpine apple orchards in South Tyrol's Adige Valley. Soil microbial diversity was assessed using shotgun metagenomic sequencing, enabling reconstruction of metagenome-assembled genomes and analysis of microbial functional potential. Focus was placed on genes linked to nutrient cycling, stress response, and plant–microbe interactions. The results will improve understanding of cover cropping as a sustainable strategy to enhance biodiversity and ecosystem functioning in alpine apple orchards.

Keywords: Cover Cropping, Soil Microbial Diversity, Shotgun Metagenomics, Alpine Apple Orchards, Ecosystem Functioning

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ST 4.13 - From fungi to function: Plant growth responses to *Mortierella-Pseudomonas* interactions

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Soil microorganisms form complex interaction networks that influence plant growth and ecosystem functioning. This study investigated how key members of the core soil microbiome affect biomass production and seed viability of *Poa alpina* in primary successional alpine environments. In a greenhouse experiment, plants were grown in sterilized quartz sand and inoculated with *Linnemannia nimbosa*, *Mortierella lapis*, and *Pseudomonas svalbardensis*, individually and in combination. Uninoculated plants served as controls. After two months, seed establishment, above- and belowground biomass, and soil organic matter development were assessed. Microbial inoculation significantly enhanced plant performance and productivity, highlighting the importance of belowground microbial interactions in nutrient-poor alpine soils.

Keywords: *Mortierellaceae*, *Poa alpina*, *Pseudomonas*, Plant growth promoting

ST 4.14 - Recurring drought and recovery dynamics of Subalpine forest microbiomes

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Subalpine forests face increasing threat from climate-driven water limitation. It is therefore of high relevance to understand how these ecosystems are affected by drought for above- and belowground components. Building on previous findings, where eight years of recurring experimental drought at Kaserstattalm (Stubai valley) revealed resistance in diversity but compositional shifts, we investigated ecosystem dynamics at its first recovery year. Utilizing soil amplicon sequencing, root-tip Sanger sequencing, and fruiting body surveys, we analyzed communities alongside soil parameters. To provide a more holistic overview, ongoing tree growth monitoring and microbial co-occurrence network analyses are also integrated. Chronic drought significantly reduced nitrogen availability and root density. While these abiotic soil parameters recovered within one year, belowground microbial communities exhibited distinct lag effects, showing no convergence between drought and control plots. Furthermore, while fungal fruiting body production increased in recovered plots, overall diversity remained unchanged.

By connecting long-term resistance with acute recovery dynamics, this study highlights a decoupling between rapid abiotic recovery and prolonged biotic responses. Merging soil microbiome data with ongoing network and tree growth analyses allows for a multi-scale approach, essential for understanding the systemic connectivity and resilience of subalpine forests under shifting climate regimes.

Keywords: Climate change, Ectomycorrhiza, Soil bacteria and fungi

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ST 4.15 - Resolving hidden fungal diversity: an integrative taxonomic revision of dermocyboid *Cortinarius* sect. *Olivaceofusci*

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Accurate species delimitation is fundamental for biodiversity assessment and conservation, yet many fungal groups remain taxonomically unresolved. *Cortinarius* subgenus *Dermocybe,* an ecologically important group of ectomycorrhizal fungi, is particularly challenging due to cryptic diversity, morphological similarity, and the lack of molecular data from historical type material. Using an integrative framework combining multigene phylogenetics, morphology, ecology, and pigment chemistry, we revised species concepts within *Cortinarius* section *Olivaceofusci* through the study of historical type specimens and recent collections. Our results provide a robust framework for interpreting fungal biodiversity patterns and reveal previously overlooked taxonomic diversity.

Keywords: *Cortinarius,* Fungal Biodiversity, Type study, Integrative taxonomy, Species delimitation

ST 4.16 - The conservation status of bryophytes in South Tyrol – A regional Red List

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Red Lists are essential tools for guiding long-term species conservation. Many bryophytes are threatened at global, continental, and regional scales. Although the Italian Red List of bryophytes was updated in 2023–2024, no Red List is currently available for South Tyrol. This project aims to assess the conservation status of bryophytes in South Tyrol following IUCN criteria, identifying threatened species, the main drivers of decline, and the most vulnerable habitats. It will also provide a framework for long-term monitoring to support effective conservation planning and evaluate future extinction risks. The project is funded by the Research Fund of the Betrieb Landesmuseen.

Keywords: South Tyrol, Bryophytes, Conservation priorities, Conservation measures, Red List status

ST 4.17 - Growth Responses of *Arabidopsis thaliana* to Mortierellaceae Fungi and a Root-Associated *Pseudomonas sp.*

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Fungi of the Mortierellaceae family, particularly those of the genus *Linnemannia*, promote plant growth through hormones, nutrient mobilisation and immune enhancement. They are often associated with plant-beneficial *Pseudomonas* bacteria, which colonise roots and suppress pathogens. However, it remains unclear to what extent the positive effects of the fungi depend on these bacteria. This study investigated the growth-promoting potential of one *Linnemannia* and one *Mortierella* species on the model plant *Arabidopsis thaliana*. Additionally, interactions with a Pseudomonas strain were analysed to determine whether co-inoculation offers additive or synergistic benefits. In a laboratory experiment, the effects of the fungi, bacteria and their combinations on plant biomass, primary root growth and root architecture were quantified.

Keywords: Mortierellaceae, *Linnemannia*, *Arabidopsis thaliana*, *Pseudomonas*

ST 4.18 - Green roofs as ecological stepping stones for urban biodiversity and ecological connectivity in the Alps

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Urbanization and climate change are increasing habitat fragmentation across Alpine regions, challenging biodiversity conservation in densely built environments. The GRACE project investigates the role of green roofs as habitats and ecological stepping stones within urban ecological networks. Across the pilot cities of Bolzano (Italy), Innsbruck (Austria), and Udine (Italy), biodiversity is assessed using a multi-taxa monitoring approach combining vegetation surveys, butterfly and orthopteran inventories, metabarcoding of arthropod communities, and automated acoustic monitoring of birds and bats. Microclimatic sensors complement biodiversity data by quantifying the environmental performance of green roofs. These data are integrated into spatial connectivity models to evaluate how green roofs contribute to species movement and habitat availability. GRACE aims to provide evidence-based guidance for biodiversity-oriented urban planning and ecological restoration in Alpine cities.

Keywords: Green roofs, Biodiversity monitoring, Ecological connectivity, Urban ecology, Nature-based Solutions

ST 4.19 - Weather patterns explain fungal diversity in a mountain lake

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Little is known about the diversity and ecological functions of fungi in mountain lakes in general and specifically for different layers. We investigated the spatiotemporal distribution of fungi in mountain Lake Tovel (Northern Italy) over more than three years (September 2021 to February 2025) using metabarcoding of the ITS gene. The upper and lower euphotic layer and the hypolimnion of the deep basin were sampled while the surface and bottom of the shallow basin. Sampling covered the year 2022, one of the hottest in Europe, and the year 2024, a very rainy year in Northern Italy. The higher diversity of fungal communities in rainy 2024 can be attributed to different aspects such as wash-in of fungi and of allochthonous material by rain. Season and layer differences were weak and related to specific statistical analyses and genera and phyla. Our study provides insights into fungal communities occurring in mountain lakes.

Keywords: Lake Tovel, Long-term monitoring, Fungal diversity, Amplicon sequencing variants

ST 4.20 - Freshwater ecosystems under observation: River monitoring within an Alpine territory (South Tyrol, Italy)

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Mountain rivers are highly vulnerable to climate change, hydromorphological alterations and land-use pressures, especially in Alpine regions. Continuous, long-term monitoring is essential to understand ecosystem resilience under changing hydrological regimes, glacier retreat and increasing human impacts. In particular, macroinvertebrate communities enable early detection of ecological changes and support reliable assessment of ecosystem status. The Institute of Alpine Environment launched the South Tyrolean Biodiversity Monitoring, applying a multi-parameter approach to assess biodiversity and long-term functional dynamics of running waters.

Across more than 9,600 km of watercourses, 120 sites are sampled on a four-year rotation, integrating biological data with habitat characteristics and abiotic parameters. This framework provides a robust baseline to describe ecological conditions, identify pressures and support river management and biodiversity conservation in Alpine environments.

Keywords: Mountain rivers, Climate change, Macroinvertebrates, Long-term monitoring, Alpine biodiversity

ST 4.21 - Do Alpine midges degrade microplastics? Insights from PA6 fibre experiments at Presena Glacier

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Recently, glacier are sink of microplastics (Mps). We investigated MP contamination and biodegradation in *Diamesa* spp. larvae collected from a proglacial stream at Presena Glacier (Italian Alps). MPs presence was assessed in 50 larvae via KOH digestion followed by μ-Raman spectroscopy. Parallel experiments evaluated differential degradation of fossil-based and chemically regenerated polyamide 6 (PA6) fibres by larvae, comparing fibre morphology against controls using optical microscopy and SEM imaging. Post-exposure analyses included ingestion verification, gene expression, and biomarker assays for oxidative stress and neurotoxicity.
Results provide novel insights into MP uptake and potential biotransformation in cold-adapted freshwater invertebrates.

Keywords: Glacier, Microplastics, Degradation, Gene Expression

ST 4.22 - Mosquito biodiversity and surveillance along altitudinal gradients in Trento Province

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Annual entomological surveillance in Trento Province urban and peri-urban areas provides critical data on mosquito biodiversity, tracking population dynamics along altitudinal gradients. Fortnightly monitoring using adult BG-traps and ovitraps, carried out between 2025 and 2026, reveals a community dominated by Invasive Alien Species (IAS) such as Aedes albopictus. Additionally, other IAS such as Aedes japonicus and Aedes koreicus are now widespread across the Province. Characterizing these altitudinal distributions and shifts in vector compositions offers crucial ecological insights. These standardized long-term surveillance activities are essential for anticipating climate-driven shifts in mosquito biodiversity and guiding targeted public health interventions.

Keywords: Invasive mosquitoes, Public health, Surveillance, Arbovirus

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