ABSTRACT BOOK

Content

Plenaries

Planetary biology plenaries

13th March 2024 - Day 1

Katherine (Trina) McMahon, University of Wisconsin, Madison

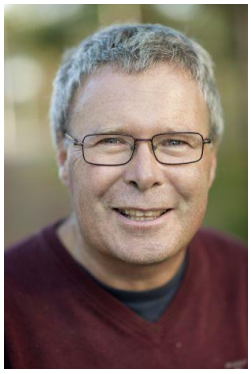
Ecogenomics of freshwater microbial communities

08:40 / Stora Salen, AF-Borgen

Freshwater bacterial communities underpin all biogeochemical cycles in lakes and are outstanding model systems with which to study ecological and evolutionary processes in microbes. We are partnered with the North Temperate Lakes Long Term Ecological Research site and have access to a rich time series of microbial community data extending nearly two decades. This includes over 500 metagenomes that we are mining to recover population genomes, infer ecophysiologies, and study changes in genome-scale diversity. Ecosystem-scale disturbances operating at multiple temporal scales are changing microbial community dynamics with implications for cyanotoxin production and overall water quality. We can observe patterns of genome-scale diversification of abundant freshwater lineages before and after these disturbances, as well as in response to seasonal and inter-annual drivers. These findings help us learn about the most influential forces shaping microbial community and population ecology, and potentially individual lineage evolution.

13th March 2024 - Day 1

David Wardle, Umeå University



Biodiversity change and ecosystem processes: where we are at and where to from here

09:20 / Stora Salen, AF-Borgen

The last three decades has seen an enormous research effort focused on determining the impacts of biodiversity (most commonly usually defined as species richness) on ecosystem functioning. Many studies have explored this through experiments in which species richness is varied as an experimental treatment, and the results are often used to inform how biodiversity loss through human activity is impairing the functioning of the Earth's ecosystems. In this presentation I first highlight eight issues that need to be addressed if we are to better understand the consequences of biodiversity change in natural ecosystems. I then discuss our ongoing work on lake islands in northern Sweden as a model system for understanding how biodiversity change in a natural ecosystem drives ecological processes and feedbacks between the aboveground and belowground subsystems. I conclude by highlighting that further progress in this field requires studies that more closely mirror species loss and gain scenarios that actually occur in nature, that involve a greater plurality of approaches, and that aim to understand the mechanisms underpinning context dependency and variation among ecosystems.

NSO and Royal Physiographic Society plenary

13th March 2024 - Day 1

Marcel Visser, NIOO-KNAW, the Netherlands

New perspectives in ecological and evolutionary research on avian seasonal timing

13:00 / Stora Salen, AF-Borgen

Seasonal timing of reproduction is a life-history trait with major fitness consequences. As avian seasonal timing in temperate-zone ecosystems is highly sensitive to spring temperatures, climate change has led to substantial advancement of the timing of reproduction over the past decades. However, other species within the food chain, such as insects and the trees these insects feed on, might have shifted at different rates. This will lead to so-called trophic mismatches. We have studied the simplified food chain of oak trees, winter moth caterpillars and great tits in our long-term population study in the Netherlands (1955-2023). In this talk I will present three examples on new approaches we used, using our work on avian seasonal timing as a red line. (1) To more accurately assess the natural selection consequences of trophic mismatches for great tits we have used genomic selection to create selection lines for early and late laying birds. The fourth generation of the aviary kept lines were released in the wild and the reproducing females of the early line indeed reproduced earlier than those of the late line but no fitness differences could be detected. (2) To assess spatial variation in the temperature sensitivity of great tit populations in their seasonal timing we analysed data from 50 European populations, making use of the SPI-Birds (www.spibirds.org) research community. Populations in locations where temperature was increasing the strongest were less sensitive to temperature. However, in a common garden experiment two populations that were, based on this meta-analysis, predicted to differ in their seasonal timing laid eggs at the same time. (3) I will present a FAIR and Open ecological research initiative in which we aim to build Digital Twins of ecosystems (LTER-LIFE; www.lter-life.nl). I will highlight two aspects, legacy data rescue and the development of Virtual Research Environments to create FAIR and Open analysis, again using seasonal timing of great tits an example.

Ernst Haeckel Award Plenary (EEF)

14th March 2024 - Day 2

Helena Freitas, University of Coimbra

Advancements in ecological science within agri-food systems

08:45 / Stora Salen, AF-Borgen

In this presentation, we explore cutting-edge breakthroughs and innovations at the intersection of ecological science and agri-food systems. From sustainable farming practices to biodiversity conservation, we highlight the efforts of researchers and practitioners to enhance resilience and environmental sustainability in food production. Our approach encompasses pivotal areas of progress, particularly highlighting the adoption of precision agriculture and regenerative farming practices. Through embracing these advancements, we pave the path towards a food system that is both resilient and ecologically sound, ensuring a lasting legacy of sustainability for future generations.

BECC Plenary

14th March 2024 - Day 2

Lynn Dicks, University of Cambridge

How does 'sustainable agriculture' really influence biodiversity (and how to find out)

13:00 / Stora Salen, AF-Borgen

The new Global Biodiversity Framework, signed by 196 countries in December 2022, sets a target for sustainable management of agricultural landscapes, including a 'substantial increase' in biodiversity-friendly practices and agroecological approaches. Conservation scientists disagree about whether these approaches should be part of a framework for biodiversity conservation at all, with some arguing strongly that they are detrimental to biodiversity at larger scales. In this talk, I will provide an overview of the issue and explain why a transition to more sustainable agriculture is necessary to secure a long-term future for biodiversity and people on Earth. Research to inform this transition without unwanted 'off-site' impacts on biodiversity must be conducted at farm-to-landscape scales, in partnership with farmers and agronomists operating in real world conditions, taking account of economic and environmental outcomes. I will use our research projects in the UK, Brazil and India, to illustrate how this approach can reveal solutions, driving sustainability from the ground up.

DDLS Plenary

15th March 2024 - Day 3

Kelly Swarts, Gregor Mendel Institute/Max Perutz Labs

Climate adapation in natural forest trees

09:15 / Stora Salen, AF-Borgen

Conifers are ecologically dominant and economically important, but under climate change mature trees are no longer adapted to their environment and are succumbing to drought, disease, early-budding and other challenges globally. If we could predict how individual tree genotypes would respond to different environments, we could — given environmental predictions — plant the right tree in the right space. Tree growth is a function of the experienced (macro- and micro-) environment but also the genetics that underlie how an individual tree responds. While tree-ring studies are dominated by a focus on environmental responses, growth measured from increment cores also carry signal from tree-specific, genetic responses. Using models derived from agricultural genomics, we isolate variation associated with tree-level genetic signals as well as tree-specific responses to environments modelled from historical weather station data. Confirmed using genetic relationships from millions of genetic variants (single nucleotide polymorphisms, or SNPs), these estimates are highly heritable and can be passed on to offspring. This makes them useful as responses in prediction modelling to evaluate tree performance in new environments and in association mapping to understand the genetic basis of how trees adapt to new environments. As environments shift under climate change, this approach promises a powerful tool to select parents for healthy, resilient forests.

Oral presentations

Session 1a -- Planetary biology: exploring and understanding biodiversity

13th March 2024 - Day 1 / 10:30 / Stora Salen, AF-Borgen

Global occurrence and productivity characteristics of snowbed habitats

Pekka Niittynen, University of Jyväskylä

Snow is a fundamental driver of ecosystem processes and species distributions at high latitudes and altitudes. Habitats characterized by prolonged snow cover, known as snowbeds, represent biodiversity hotspots in mountain and tundra regions, yet face significant threats due to climate warming. Despite the importance of snowbeds, acquiring local information on snow cover poses challenges, and a global assessment of the extent and types of snowbed habitats is lacking. Here, a novel R package and workflow are introduced to generate snow cover duration from Landsat satellite imagery at a spatial resolution of 30 meters, applicable to any forestless area on Earth. The initial results include mapping of snow cover duration and the extent of snowbed habitats, covering 600 study sites across the Arctic, Antarctic, and alpine regions worldwide. Additionally, the study explores the relationship between snow cover duration and vegetation productivity within and across the studied tundra regions.

Generating practical biomonitoring outputs from high-throughput data: State-of-the-art methodologies and knowledge gaps

Mira H. Kajanus, University of Jyväskylä

Ongoing environmental change and subsequent species declines urge the need of generating rapid knowledge on the state of biodiversity. Recent methodological advances have massively increased biodiversity data generation. In particular, automated methods based on high-throughput data collection and processing have recently undergone major developments, opening new possibilities for rapidly generating massive amounts of data on biodiversity. In spite of the promising recent advances in the development of high-throughput methods to collect massive amounts of biodiversity data as well as rapid advancements of statistical and machine learning methods to analyze large data volumes, there are still important gaps in the methodological pipeline to derive practical biomonitoring outputs. Lacking tools for generating biomonitoring outputs rapidly hampers real-time decision making and thus has important consequences for species conservation and management.

Interactions of climate and land-use change as drivers of broad-scale biodiversity change in the Anthropocene

Alistair Auffret, Swedish University of Agricultural Sciences

Interactions between habitat destruction and climate change are predicted to have devastating effects on biodiversity. However, a lack of baseline data means that their effects on large spatio-temporal scales are largely unknown. Analysing historical maps over southern Sweden and the whole of Great Britain, we quantified the extent of habitat destruction during the past 50+ years. Combining this information with climate data and observations of plants, butterflies and birds, we show that in Sweden, climate warming in combination with grassland encroachment appears to have accelerated species loss. In Britain, such interactive effects were rare. Habitat specialists did show negative trends, but there were overall more species gains than losses. Despite these differences, it is clear that the retention and restoration of natural and semi-natural habitats is vital for biodiversity, while evidence of time-lagged responses to environmental change suggests that there may yet be more losses.

Global data synthesis reveals that disproportionate declines of formerly abundant species underlie insect loss

Roel van Klink, German Centre for Integrative Biodiversity research & Martin-Luther-University Halle-Wittenberg, Germany / Diana E. Bowler, Centre for Ecology and Hydrology, Wallingford, UK / Konstantin B. Gongalsky, Russian Academy of Sciences, Moscow, Russian Federation / Minghua Shen, German Centre for Integrative Biodiversity research & Martin-Luther-University Halle-Wittenberg, Germany / Scott R. Swengel, Baraboo, Wisconsin / Ann M. Swengel, Baraboo, Wisconsin / Jonathan M. Chase, German Centre for Integrative Biodiversity research & Martin-Luther-University Halle-Wittenberg, Germany

Cases studies across the globe have reported losses of insect biomass, abundance or diversity, but the generality of these patterns has long remained unclear. Synthesizing across the long-term trends of 923 terrestrial insect assemblages monitored in 106 studies, we found concomitant declines in abundance and species richness. At the population level, we found that species that were most abundant at the start of the time series showed the strongest average declines. Rarer species were, on average, also declining, but these were offset by increases of other species. Our results suggest that the observed declines in total insect abundance can mostly be explained by widespread declines of formerly abundant species. This counters the common narrative that biodiversity loss is mostly characterized by declines of rarer species. Given the importance of abundant species in ecosystems, their general declines likely have broad repercussions for food webs and ecosystem functioning.

The potential evolution of Sweden's boreal forest through biodiversity-focused development in the 21st century

Cristian S. Montalvo-Mancheno; SLU Swedish Species Information Centre, Swedish University of Agricultural Sciences, Uppsala Sweden/ Ross Wetherbee; Department of Environmental Sciences, Western Norway University of Applied Sciences, Sogndal, Norway/ Federico Lingua; SLU Swedish Species Information Centre, Swedish University of Agricultural Sciences, Uppsala Sweden/ Tord Snäll; SLU Swedish Species Information Centre, Swedish University of Agricultural Sciences, Uppsala Sweden

Striking a balance between utilizing forests and conserving them is paramount in the 21st century. Yet, little attention is devoted to understanding the consequences for biodiversity when aligning forest development with various aspects of species diversity. Here, we explored how Sweden's boreal forest might differ when striving for optimal solutions based on beetle diversity. By integrating forest development simulation with species distribution modeling in a multi-objective analytical framework, we found that achieving high levels of beetle richness negatively influenced the representation of both beetle habitats and functional diversity. Notably, this effect was less marked for the 2100 optimization than for the 2030 alternative, with the former yielding the largest trade-off in harvesting levels. For attaining a sustainable future, it is thus crucial to consider the transformative impact of a biodiversity-oriented approach to forest development, both in the short and long term.

Plant community turn-over in European raised bogs along enviro-climatic gradients

Janna M. Barel, Department of Ecology, Radboud Institute for Biological and Environmental Sciences, Radboud University, Nijmegen, The Netherlands/Yvet Telgenkamp, Department of Ecology, Radboud Institute for Biological and Environmental Sciences, Radboud University, Nijmegen, The Netherlands/ Bjorn J.M. Robroek, Department of Ecology, Radboud Institute for Biological and Environmental Sciences, Radboud University, Nijmegen, The Netherlands

Northern peatlands safeguard the world's densest terrestrial carbon stocks, but their carbon sink-function hinges on plant productivity outpacing organic matter decomposition. Changing enviro-climatic conditions modify plant species distributions with potential cascading effects on ecosystem functioning, yet it is unclear how peatland plant-soil interactions and subsequently carbon- and nutrient cycling are affected. We surveyed 16 raised bogs along natural enviro-climatic gradients across Europe and assessed the taxonomic composition of their bryophyte and vascular plant communities. We project these data to plot-level soil- and pore water chemistry, and site-specific environmental and climatic data to assess how vegetation shifts relate to spatial variation in enviro-climatic conditions. Further, we compare our vegetation data with a survey conducted at the same locations 10 years prior and evaluate how large-scale patterns of plant species distribution have changed this past decade.

Session 1b -- Planetary biology: exploring and understanding biodiversity

13th March 2024 - Day 1 / 13:55 / Stora Salen, AF-Borgen

Introduction to Planetary Biology: a planetary perspective on biodiversity

Stefan Bertilsson, Swedish University of Agricultural Sciences

No abstract.

Global drivers of aquatic plant height

Lars Baastrup-Spohr, University of Copenhagen/ Yang Liu, Wuhan Botanical Garden/ Lars L. Iversen, McGill University

Plant height is a major indicator of ecological fitness in both the terrestrial and aquatic realm. While terrestrial plant height decreases with latitude, with water availability and temperature as mains drivers, the large-scale-pattern and drivers of aquatic plant size remain unexplored. As aquatic plants have ample water supply, other large-scale environmental gradients such as temperature, water depth and inorganic carbon availability could influence the height of this organism group. Using plant heights, life-form information and global distribution for 1729 aquatic plants (emergent and submerged), we tested the influence of large-scale environmental drivers on plant community height. Emergent plant height decreased with latitude while submerged plant height showed the opposite pattern. Our models suggested that heights of emergent increases with temperature while heights of submerged plants are promoted by the supply of inorganic carbon and negatively influenced by temperature.

Genome variation in arctic bumblebees

Yuanzhen Liu, Uppsala University / Matthew J. Christmas, Uppsala University / Anna Olsson, Uppsala University / Tuuli Larva, Uppsala University/ Aoife Cantwell-Jones, University College London / Richard J. Gill, University College London / Björn Cederberg, Swedish University of Agricultural Sciences / Matthew T. Webster, Uppsala University

Many bumblebee species are in decline, with distributions shifting northwards to track suitable climates. Arctic and montane species are particularly vulnerable to climate change. We used genome sequencing to analyse genetic variation in several related bumblebee species from northern Sweden and the Rocky Mountains, USA.

We find relatively high Ne and low population structure indicating that none of the species are at immediate risk of negative effects of genetic drift. However, reconstruction of historical fluctuations in Ne indicates that some species have experienced population declines since the last ice age. In addition, genomic analysis indicated the presence of a previously unknown cryptic species. Although levels of genetic variation in montane bumblebee populations are relatively high, their ranges are predicted to shrink drastically due to the effects of climate change and monitoring is essential to detect future population declines.

Large scale range dynamics of vascular plant species in Sweden

Matilda Arnell, Stockholm University / Alistair Auffret, Swedish University of Agricultural Sciences / Kristoffer Hylander, Stockholm University

One challenge to understanding how species respond to climate and land-use change is the lack of baseline data. This is part of a project where we compare historical and current occurrence data across Sweden and analyze how climate and land-use change interactively can explain range dynamics. Our historical database consists of range maps from 1971, which are based on regional floras, herbarium records and expert opinions. The current data includes modern regional plant atlases as well as citizen science data. By estimating and correcting for recorder effort we produce robust estimates of trends in occurrence frequency for more than 1600 vascular plant species across Sweden. Preliminary results show that approximately half of the species in our study increase in frequency while a third of the species have decreased in frequency over the last 50 years.

Microbial community diversity in coastal Northern Baltic Sea revealed by metagenomic analyses

Li Zhao 1Department of Ecology and Environmental Science, Umeå University, SE-901 87 Sweden ; Umeå Marine Sciences Centre, Umeå University, SE-905 71 Hörnefors, Sweden/ Sonia Brugel Department of Ecology and Environmental Science, Umeå University, SE-901 87 Sweden; Umeå Marine Sciences Centre, Umeå University, SE-905 71 Hörnefors, Sweden/Kesava Ramasamy Department of Ecology and Environmental Science, Umeå University, SE-901 87 Sweden ; Umeå Marine Sciences Centre, Umeå University, SE-905 71 Hörnefors, Sweden/ Karolina Eriksson Department of Ecology and Environmental Science, Umeå University /Wei Zhao Department of Ecology and Environmental Science, Umeå University/Xiao-Ru Wang Department of Ecology and Environmental Science, Umeå University /Agneta Andersson Department of Ecology and Environmental Science, Umeå University; Umeå Marine Sciences Centre, Umeå University

Increased precipitation in northern Europe associated with climate change will flush more terrestrial dissolved organic matter (tDOM) to the sea, the influence on the plankton inhabiting coastal areas is still poorly known. This study aims to understand the composition and diversity bacterioplankton communities in the subarctic land-sea transitional zone of the northern Baltic Sea. The results indicate that temporal variations in physicochemical variables, such as temperature and

nutrient availability, have a greater impact on the bacterial communities than spatial differences in the ecosystem. The seasonal shift in the relative abundance of these bacterial classes suggests that environmental factors and ecological processes drive changes in the abundance of different bacterial classes over time. Our findings improve the understanding of the factors shaping bacterioplankton community composition and diversity in northern coastal areas, such as in the northern Baltic Sea.

The effects of forest structure on biodiversity

Lydwin Freija Wagenaar / Lund University

For centuries, human use has changed the structure of forests which has negatively impacted biodiversity. To counteract these effects, forest restoration and rewilding have become highly discussed practices among stakeholders working with environmental issues. Even though a good understanding of how restoration and rewilding practices affect forest structure is a key element of effective restoration projects, there is still uncertainty about which forest structures these efforts should focus on.

Here, I will present a systematic mapping of how forest structure affects the biodiversity in deciduous forests. The study identifies forest structure characteristics that increase the habitat quality and research gaps within this research area. I will also present an overview on how this information can be further used in restoration and rewilding practices.

This talk will increase the understanding of biodiversity patterns in deciduous forests and will inform restoration practices globally.

Session 2 -- Ecological and evolutionary solutions to the biodiversity crisis

13th March 2024 - Day 1 / 10:30 / Palaestra A

Historical butterfly genomes highlight species-specific genomic consequences of grassland conversion and abandonment

Zachary J. Nolen / Lund University / Patrycja Jamelska / Lund University / Ana Sofía Torres Lara / Lund University, University of Bremen / Niklas Wahlberg / Lund University / Anna Runemark / Lund University

Curbing biodiversity loss requires maintenance of diversity at all levels. While efforts to monitor and maintain ecosystem and species diversity have been the primary focus of conservation practices, we are only beginning to examine the extent and patterns of genetic diversity decline in the wild. Here, we utilize whole genome data from modern and museum samples of three grassland butterfly species to examine genetic erosion over the 100 years. We ask if habitat specialists face a greater loss of genetic diversity compared to generalists in landscapes where intensification of agriculture and forestry degrade and fragment grassland habitat. We infer if populations are now more isolated, with increases in inbreeding and genetic load that would indicate genetic components are now reinforcing species decline. Our work demonstrates how genomic methods can have an invaluable role in addressing the biodiversity crisis by identifying species under greater threat than their abundance suggests.

Using the past to inform the future: characterizing extinction risks of the Danish flora

Ditte Marie Christiansen, Department of Plant and Environmental Science, University of Copenhagen / Hans Henrik Bruun, Department of Biology, University of Copenhagen / Conny Bruun Asmussen Lange, Department of Plant and Environmental Science, University of Copenhagen / Sergey Rosbakh, Department of Plant and Environmental Science, University of Copenhagen

Land-use and climate change alter species distributions and are known drivers of biodiversity loss. To predict and mitigate such changes, we need a deeper understanding of the underlying mechanisms. The limited temporal resolution of biodiversity data - often only extending a few decades back in time – constrains our inference . However, printed historic distribution maps of the Danish flora represents an untapped resource of past species occurrence patterns. Using advanced image analysis techniques to digitize these maps, we here first report changes in occurrence of more than 1000 vascular plant species during the past century. Combined with extensive information on plant ecology, phylogeny, and biology, and using novel statistical methods, we expect to define characteristics of plant extinction risks that will guide plant conservation and restoration efforts.

Quantitative spatial variation of plant communities along a landscape gradient in Central Norway.

François Lazarus, Gjærevoll center (NTNU)

Plant community distribution and structure are determined by a variety of abiotic, biotic and disturbance factors in addition to being the result of stochastic events. Knowledge of the relative importance of drivers determining plant community characteristics such as species composition, richness and abundance are crucial to design tools to predict the areas of interest for environmental conservation or restoration. Across typical nature types of central Norway, I used vegetation

monitoring program datasets and a Joint Species Distribution Models (JSDM) approach to (1) identify the main drivers of community variation trough variance partitioning, (2) assess the extent to which environmental variables explain and predict plant community compositions, and (3) understand their spatial structure by constructing species-area curves. This study has implications for cost-effectively selecting areas to preserve and restore and for evaluating the efficiency of monitoring programs.

Effects of Habitat Fragmentation per se on the Genetic Diversity of the Glanville Fritillary Butterfly

Audrey Bras /1Research Centre for Ecological Change, Organismal and Evolutionary Biology Research Programme, Faculty of Biological and Environmental Sciences, University of Helsinki, Helsinki, Finland; 2Helsinki Institute of Life Science, University of Helsinki, Helsinki, Finland / Lola Fernandez Multigner/1Research Centre for Ecological Change, Organismal and Evolutionary Biology Research Programme, Faculty of Biological and Environmental Sciences, University of Helsinki, Helsinki, Finland; 2Helsinki Institute of Life Science, University of Helsinki, Helsinki, Finland / Michelle DiLeo/Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry, Peterborough, ON, Canada / Marjo Saastamoinen/1Research Centre for Ecological Change, Organismal and Evolutionary Biology Research Programme, Faculty of Biological and Environmental Sciences, University of Helsinki, Helsinki, Finland; 2Helsinki Institute of Life Science, University of Helsinki, Helsinki, Finland

Habitat loss and fragmentation are considered main drivers of biodiversity loss. The Habitat Amount Hypothesis (HAH) proposes that fragmentation per se, breaking apart of habitat while the habitat amount stays constant, has no or a positive effect on biodiversity. HAH has been tested at the species richness level, whereas potential effects on genetic diversity are understudied. Using the well-defined habitat patches of the Glanville fritillary butterfly in the Åland islands, we tested the effects of fragmentation per se on genetic diversity using 40 SNP neutral markers. We first estimated the appropriate landscape size to be a 3.5 km radius around each focal patch, then selected patches with surrounding landscapes of similar habitat amount but various number of patches, and finally assessed their respective effect on genetic diversity. Fragmentation per se had a neutral effect on genetic diversity supporting the HAH, and all fragments likely contributed to maintain genetic diversity.

Grasslands and crop fields are complementary for biodiversity irrespective of landscape grassland cover

Fabian A. Boetzl, Swedish University of Agricultural Sciences, Department of Ecology, Uppsala, Sweden / Giovanni Tamburini, Department of Soil, Plant and Food Sciences (DiSSPA – Entomology), University of Bari, Bari, Italy / Erik Öckinger, Swedish University of Agricultural Sciences, Department of Ecology, Uppsala, Sweden / Ola Lundin, Swedish University of Agricultural Sciences, Department of Ecology, Uppsala, Sweden

Temperate agricultural landscapes are experiencing an unprecedented erosion of biodiversity yet the relative contribution of crop and non-crop habitats to biodiversity has been surprisingly little studied. Using 86 paired permanent grasslands and oilseed rape fields across five European countries, we assessed how habitat type and cover of permanent grasslands in the surrounding landscapes affected species richness across multiple taxa. Species richness and diversity were generally determined by habitat type and country but not by the the cover of permanent grasslands. Habitat type shaped species assemblages in most taxa and both habitats hosted a considerable share of unique species. Our results indicate that local biodiversity is not necessarily determined by surrounding non-crop habitat amount and that crop fields, contribute significantly to the regional species pool. Biodiversity friendly local habitat management is thus needed in both grasslands and crop fields.

Can we reach the dual biodiversity goals of preserving rare and ecosystem service provisioning species in farmland

Smith, Henrik .G., Lund University / Brady, Mark, SLU / Carrie, Romain, Lund University / Ekroos, Johan, Helsinki University / Olsson, Ola / Lund University / Persson, Anna, Lund University / Sidemo Holm, William, Lund University / Wätzold, Frank, Brandenburg Technische Universität / Weber, J., Lund University

Biodiversity conservation is both about halting species loss and maintaining ecosystem services, but these goals may not coincide. A theoretical model demonstrate that spatial targeting of habitat conservation and modulation of agricultural intensity can result in more effective conservation than uniform strategies, by promoting species conservation in low- and benefitting ecosystem service providers in high-productive landscapes. This was caused by spatial variation in opportunity costs of conservation as well as marginal benefits of increasing ecosystem service providers. In a landscape study, we evaluated the combined use of conservation of semi-natural grasslands and organic farming benefit plants and pollinators across landscapes. Using data on farm economy and biodiversity, economic-ecological modelling demonstrates benefits of modifying agri-environment schemes, to achieve multifunctional landscapes delivering both biodiversity conservation and ecosystem services.

Session 3a -- Ecological and evolutionary consequences of species interactions

13th March 2024 - Day 1 / 10:30 / Palaestra B

Components of local adaptation and divergence in pollination efficacy in a coevolving species interaction

Karin Gross - Department of Environment and Biodiversity, Paris Lodron University Salzburg, Salzburg, Austria / Malin Undin - Department of Natural Sciences, Mid Sweden University, Sundsvall, Sweden / John N. Thompson - Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, California, USA / Magne Friberg - Department of Biology, Lund University, Lund, Sweden

The challenge is to understand how traits of interacting species combine to shape local adaptation directly or indirectly resulting in diversification. We evaluated local divergence in pollination efficacy in Lithophragma bolanderi (Saxifragaceae) and its two specialized Greya (Prodoxidae) pollinators – both pollinate during nectaring, G. politella also while ovipositing. One population was visited only by G. politella, the other by both species. Several floral traits differed between populations. In lab experiments, local nectaring moths of both species pollinated flowers more efficiently than non-local moths, and pollination efficacy was higher for local ovipositing G. politella for the L. bolanderi population relying stronger G. politella. Oviposition behavior differed between G. politella populations, suggesting local adaptation also in Greya. This is a rare example of components of local coadaptation contributing to divergence in pollination efficacy in a coevolving interaction.

The evolution and ecological drivers of variation in chemical defences in the Wood Tiger Moth (Arctia plantaginis)

Cristina Ottocento, University of Helsinki/ Bibiana Rojas, Konrad Lorenz Institute of Ethology, University of Veterinary Medicine Vienna/ Emily Burdfield-Steel, University of Amsterdam/ Johanna Mappes, University of Helsinki

Despite the selective pressure from predators, chemical defences in aposematic organisms, such as the wood tiger moth (Arctia plantaginis), exhibit unexpected variation within and across species. We investigated the variation in pyrazine, a major component of their defences secreted in response to attacks by avian predators, across different wood tiger moth populations and its impact on predator behaviour. We explored whether resources, such as proteins, play a key role in the production of this moth's defences and warning signal. We found that the defences

of wild moths are influenced by local predation pressures. Moths reared on high resources had more deterrent defences than moths raised on low resources, whereas warning signals were only marginally influenced by food availability. In conclusion, resources significantly shape the effectiveness of chemical defences, while warning signals exhibit resilience in the face of variable environmental conditions.

Temperature-Dependent Influence of Aphid Endosymbionts on Ladybug Predation Efficiency

Katrine B. Thomsen, Aalborg Universitet / Professor Ary A. Hoffmann, The university of Melbourne / Perran A. Ross, The university of Melbourne / Alex Gill, The university of Melbourne / Eloïse Ansermin, The university of Melbourne / Michael Ørsted / Professor Torsten N. Kristensen, Aalborg Universitet

Aphids cause major economic losses to growers worldwide. Current management strategies rely heavily on insecticides, but efficiency is waning as aphids rapidly build resistance. Introducing secondary endosymbionts into aphids offers a novel tool in pest management, as they induce host fitness costs and spread through the populations. These are properties useful in reducing aphid pest populations. However, the secondary endosymbionts' impact on aphid-predator interaction remains poorly studied. We investigate the predation efficiency of ladybirds, Adalia bipunctata, on aphids, Myzus persicae, with and without the secondary endosymbionts Rickettsiella viridis and Regiella insecticola across different temperatures. Generally, ladybirds are more efficient when predating on aphids without these endosymbionts, but the efficiency was highly temperature and endosymbiont-specific. This denotes the intricate relation between secondary endosymbionts, temperature, and predation efficiency.

Insect communities in Italian Arabis alpina populations with diverging scent profiles

Aarushi Susheel - Lund University / Hanna Thosteman - Lund University / Katherine Eisen - Loyola Marymount University / Loretta Pace - University of L'Aquila / Magne Friberg - Lund University

Most flowering plants need insect pollinators to increase their reproductive success. This dependence is one of the driving forces behind the speciation and diversification of angiosperms. The generalist herb Arabis alpina exhibits large intraspecific variation in scent bouquet composition. This variation is most prominent among central Italian populations that are genetically and geographically close. We believe this is a result of pollinator-mediated selection. Through pollinator observations, we measured insect visitation rates in 7 populations and compared the visiting insect communities. The communities were distinct across populations, but were constant across two years. We also performed scape translocations to

measure insect preference to local vs foreign scents. Local scapes had higher visitation rates. Pending analyses into potential correlations between insect and floral morphology could indicate a coevolutionary relationship between the local communities and Arabis alpina.

A functional view on pollinator-mediated floral evolution

Øystein Opedal, Department of Biology, Lund University

Plant-pollinator interactions and their consequences for floral evolution provide ideal systems for understanding (rapid) adaptation in the event of environmental change. First, the agents of selection driving adaptation (pollinators) and the mechanisms linking phenotypes to fitness (pollination) are often known. Second, flowers are complex phenotypes which proper functioning (e.g. pollen transfer) depends on precise coordination of traits, allowing insights into multivariate phenotypic evolution and constraint. I will present a functionally explicit fitness-function framework for studies of pollinator-mediated floral evolution and draw on insights from several study systems and meta-analyses to show how a functional perspective can reveal surprising predictability of phenotypic evolution. I will focus on plant evolutionary responses to pollinator declines and changes in pollinator assemblage composition.

Host-microbiome interactions affect ecology and evolution of orchids

Ida Hartvig, Center for Evolutionary Hologenomics, University of Copenhagen / Chatchai Kosawang, IGN, University of Copenhagen / Melissa McCormick, Smithonian Environmental Research Center, Smithsonian Institute / Dennis Whigham, Smithonian Environmental Research Center, Smithsonian Institute / Erik Dahl Kjær, IGN, University of Copenhagen / Lene R Nielsen, University of Copenhagen

With their dependency on specific fungi and often narrow niches, orchids are great for exploring how interactions with microorganisms are tied to ecology and evolution of plants. Orchids need to acquire specific orchid mycorrhizal fungi from their environment for germination and the availability of suitable fungi determines their local distribution. My research on fungal use in terrestrial orchids showed that fungal microbionts differ among co-occurring orchids, confirming a host effect on microbiome and indicating that adaptation to different fungi aid to niche diversification. Exploration of fungal use in a large orchid genus showed that fungal use generally differed among species, and that more closely related taxa were more likely to overlap in fungal use than more distantly related taxa. This indicates that specialization to different fungi have played a role in differentiation of orchid lineages, suggesting a significant role of interactions with microbes in evolution of orchids.

Session 3b -- Ecological and evolutionary consequences of species interactions

13th March 2024 - Day 1 / 13:55 / Palaestra A

Duration of coexistence with a novel type of invasive predator increases survival of Idotea balthica

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Invasive species threaten native biodiversity through changes in biotic interactions. Because of the lack of coevolutionary history native species face novel selection pressure. Thus, we investigated whether adaptive anti-predator responses arise in prey populations exposed to predation by the invasive mud crab Rhithropanopeus harrisii in the Baltic Sea. We ran predation experiments using an abundant herbivore, Idotea balthica, collected from populations differing in how long they have been exposed to R. harrisii (naïve, recently invaded, and experienced). We found that naïve populations have the highest risk of mortality, and found differences in behavioural responses to the predator among the experience levels. This suggests that adaptive responses reducing susceptibility to a novel predator has arisen in I. balthica. We conclude that it is important to consider the evolutionary consequences of invasions, to fully understand the impacts of invasions and their temporal progression.

One-sided population decline triggers eco-evolutionary interaction disinvestment in a 2-species mutualistic system

Franz Weyerer, University of Tübingen / Avril Weinbach, CEC, Lund University, University of Hohenheim / Christiane Zarfl, University of Tübingen / Korinna T. Allhoff University of Hohenheim

The decreasing abundance of one mutualistic partner might force its interactor to invest less in the interaction to reduce energy waste at the cost of accelerating the initial partner decline. We ask under which conditions such self-reinforcing feedback occurs in mutualistic systems with one declining partner. We address these questions using a mathematical model and adaptive dynamics tools. We observe that when both partners are co-evolving, the undisturbed population disinvests first, forcing the declining population to disinvest as well, in favour of other energy sources. A decelerated decline can occur if the adaptation of the undisturbed partner is too slow compared to the environmental change, reducing

the speed of its disinvestment, or if the initial investment into the interaction was very high. Our results suggest the importance of considering interaction partners and their interaction type and strength, when planning restoration attempts to save a target population.

Arctic greening drives changes in the diet and gut microbiome of a resident herbivore with consequences for fitness

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Rapid climate warming is “greening” the tundra due to higher plant productivity, potentially changing the nutritional base for herbivores. However, the consequences for herbivores are unclear. In a model system, the Svalbard reindeer, we investigate how climate-induced changes in diet and the gut microbiome impact reindeer body mass. Using DNA metabarcoding, we quantified diet and microbiome composition in October from 1998 to 2004. The proportion of the dwarf shrub Salix polaris in the reindeer diet increased with the maximum normalised difference vegetation index and had a significant positive effect on autumn body mass. Structural equation modelling revealed a significant positive effect of Salix on the microbiome diversity but no microbiome-mediated positive effect on body mass. Our results suggest a positive impact of Arctic greening on Svalbard reindeer fitness and emphasize the importance of the diet-gut microbiome nexus in facilitating species adaptability to climate change.

Inferring the distribution of interactions: bringing evolution into models of joint species distribution

Mariana P. Braga, SLU / Jussi Mäkinen, University of Helsinki / Nicolas Chazot, SLU / Marjo Saastamoinen, University of Helsinki / Tomas Roslin, SLU

Although niche-based species distribution models can predict changes in geographic distribution due to climate and land use change rather well, they are not as good at predicting interactions. Even when species distributions overlap, the predictability of actual formation of interactions is low. My current project proposes a solution to this problem by combining state-of-the-art models of joint species distribution (JSDMs) and models of host repertoire evolution. A new phylogenetic

modelling framework is being developed for inference of non-expressed host useabilities in order to quantify the probability of interactions between a given parasite and all available hosts. Based on the estimations of co-occurrence and interaction potential, we will construct probabilistic networks for different time points in the future, which will allow us to quantify the impact of climate and land use change on network stability, as well as the risk of co-extinction.

The role of introgression from Pacific to spring-spawning Baltic herring to adaptation to a novel environment

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Introgressive hybridization can allow adaptation to new environments, but it can also impact fitness and compromise species survival. We study the role of genomic introgression for adaptation and divergence in two sister marine fish species, the Atlantic and Pacific herring, which are in contact in the Arctic Ocean. Using high-coverage whole genomes of 125 individuals representing the distribution of Atlantic and Pacific herring as well as the contact zone, we confirm previously described signatures of gene flow from Atlantic to Arctic Pacific herring, but find almost no introgression in the opposite direction. The remarkable exception is the spring-spawning Baltic herring ecotype, where we find Arctic Pacific introgression in high frequency in approximately 0.29% of the genome. Our analysis suggests that the introgressed genomic regions harbor genes involved in body growth and lipid metabolism and thus may have contributed to ecological adaptation in the Baltic Sea.

Breeding dispersal in an endangered sea duck under increased predation risk

Ida Hermansson, Åbo Akademi University & University of Helsinki / Markus Öst, Åbo Akademi University / Mikael von Numers, Åbo Akademi University / Kim Jaatinen, Nature and Game Management Trust Finland

Breeding dispersal, i.e., movement between successive breeding sites, is poorly understood. Breeding dispersal may aid predator avoidance if individuals adopt a ‘win-stay, lose-switch’ strategy, but it also depends on individual traits. We studied the drivers of breeding dispersal of female common eiders (Somateria mollissima),

a ground-nesting duck with high site-fidelity, during 21-years (2003-23) in SW Finland, Baltic Sea.

Predation on this population has increased dramatically, which led us to expect increased dispersal over time. We used long-term data on individual traits and environmental factors, to clarify which factors affect dispersal, based on GPS data on nest locations of known individuals. We also analysed the probability of changing breeding colony and whether such change was directed toward mainland with less intense eagle predation. Preliminary results suggest that breeding dispersal was mainly determined by breeding success and adult predation risk.

Session 4 -- Environmental threats from pollution and pesticides

13th March 2024 - Day 1 / 10:30 / Kerstinsalen, AF-Borgen

How does exposure to soot, a common urban air pollutant, affect birds and bumblebees? A physiological perspective

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Particulate pollutants, such as soot, have become a major contributor to human morbidity and premature mortality. In cities, soot is mostly generated from traffic and, thus, urban-dwelling animals are also exposed to it. Yet, the potential effects of this pollutant on their physiology are poorly understood. Birds and bumblebees are common urban taxa with a highly efficient respiratory system, which may make them especially sensitive to soot toxicity. Here, we experimentally investigated the impact of different forms of soot on the oxidative stress physiology of these taxa. In birds, soot exposure induced lower antioxidant levels than exposure to clean air, but the strength of the effect depended on the form of soot. In bumblebees, similar effects are predicted but not confirmed, as lab analyses are currently underway. Our research aims to elucidate the physiological mechanisms by which soot affects organisms, hence providing a basis to establish better wildlife protection measures.

Effects of glyphosate and glyphosate-based herbicide on learning and memory of the buff-tailed bumblebee

Kimmo Kaakinen / University of Turku / Satu Ramula / University of Turku / Olli Loukola / University of Oulu / Marjo Helander / University of Turku

Glyphosate-based herbicides (GBHs), initially deemed safe for non-target organisms, have raised concerns due to recent studies suggesting their potential non-lethal impact on pollinators. This study investigated the effects of field-realistic glyphosate doses on bumblebee memory and learning. Using both pure glyphosate and a commercial GBH, we found that pure glyphosate impaired bumblebee learning, while the GBH showed no observable impact, despite containing the same glyphosate dose. These findings spotlight risks associated with once-deemed safe agrochemicals for pollinators, emphasizing the need for thorough pesticide risk assessments, including cognitive evaluations in pollinators.

Impacts of aquatic pollution on pollinator health and activity

Corrie Nyquist, Lund University/ Björn Klatt, Lund University/ Pablo Urrutia Cordero, IMDEA Water Institute

Pollinators are threatened by stressors from modern agricultural practices and industrial pollution. Much of the research on bee health has focused on terrestrial habitats with little attention to aquatic environments and water quality within agricultural landscapes. Increased climate warming and human activity are linked to increased blooms of blue-green algae (Cyanobacteria) which produce toxins proven to harm many animals, including invertebrates. Bees are known to collect water for use in the hive for thermoregulation and diluting honey and typically prefer “dirty” water with salts and other compounds as a source of micronutrients. However, this foraging also increases their likelihood of exposure to toxins. We found that bees exposed to environmentally relevant concentrations of cyanotoxins had significantly reduced survival. We also show how bumblebees are affected by exposure to toxins from cyanobacteria under increased temperature such as predicted under climate change.

Seasonal dynamics of wastewater-impacted river microbiomes and its influence on organic pollutant degradation

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The natural variability in species composition, ecological interactions, and complex mixtures of chemical pollutants impede the development of a standardizable and systematic approach to freshwater monitoring and assessment. Wastewater treatment plants (WWTP) introduce pollutants into receiving waters, but microbial community response to effluent discharge is not well understood. Studying the spatiotemporal variation and seasonal dynamics of the impacted microbiome could improve our understanding of the relationship between microbial communities and ecosystem health. Here, we quantified ecological processes regulating the seasonal assembly of microbial communities from WWTP-impacted rivers. The aim was to understand the seasonal organization and dynamics of microbial community assembly and determine the role of ecological processes in WWTP-impacted rivers.

Long-wavelength artificial light attracts male common glow-worms

Linnea, Kivelä, University of Helsinki / Christina, Elgert, University of Helsinki / Topi, Lehtonen, University of Helsinki / Ulrika, Candolin, University of Helsinki

Light pollution is a severe threat to dark-adapted species, especially insects. Many insects are strongly drawn to short-wavelength (blue and UV) light, and thus adjustment of artificial lights towards longer wavelengths has been proposed as a mitigation measure. However, the effectiveness of this measure is likely to vary between species. In this study, we assessed the color sensitive phototaxis of male common glow-worms, a species of nocturnal beetle known to be negatively affected by light pollution, with particularly white light disrupting mate finding. We quantified light attraction using an experimental arena illuminated from one end with either white, yellow, red, or no artificial light. Male glow-worms displayed attraction to yellow and red light, and repulsion to white light. The results indicate

that spectral tuning of lights towards longer wavelengths is not an innocuous option for glow-worms, as male attraction to long wavelength light could result in an evolutionary trap.

Disruption of oxidative balance due to heavy metals exposure in a wild ungulate

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The accumulation of non-essential elements in tissues is toxic even at low levels and impairs wildlife health. However, the underlying physiological mechanisms are not fully elucidated and remain to be studied under natural conditions. Using a wild ungulate model, we tested whether a compromised oxidative balance (accumulation of oxidative damages and/or low antioxidant levels) was associated to high levels of heavy metals. We collected hair and blood samples from 429 roe deer captured in two French populations. We measured hair concentrations of nine metals and plasma levels of five markers of oxidative balance. We showed an increase in antioxidant defenses (OXY) and oxidative damages on proteins (Carbonyls) with increasing heavy metal levels. These relationships differed according to population, age and body mass. This study suggests that the exposition to heavy metals can disrupt the oxidative balance, with expected implications for individual performance and population viability.

Session 5 -- Open session 1

13th March 2024 - Day 1 / 13:55 / Palaestra B

Modeling large grazers of the mammoth steppe

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During the last glacial, a continent-spanning cold-steppe was home to a diversity of large herbivores — a long-vanished ecosystem without modern analog. Much has been conjectured about potential densities of Pleistocene megafauna, but few studies have attempted to derive estimates based on ecophysiological mechanisms. One approach is to dynamically integrate vegetation and herbivores in a mechanistic model in which population–level carrying capacity emerges bottom up from individual–level processes. We developed such a physiological grazer model, integrated in an existing dynamic vegetation model. Results from Bayesian simulations lend credibility to megafauna densities lying between the very high and very low published estimates. In addition, a sensitivity analysis identified primary production as the strongest driver of uncertainty. Posterior parameter distributions for background mortality quantify the low hunting tolerance of woolly mammoths. Our model is open-source and reusable.

Enhancing Reliability in Matrix Population Models: From Uncertainty Propagation to Simulation with mpmsim

Owen Jones, University of Southern Denmark

Matrix population models (MPMs) are critical tools for understanding ecological and evolutionary dynamics, but their reliability hinges on the appropriate treatment of uncertainty in demographic rates. I first evaluate current practices, noting that many studies overlook this crucial aspect, which may lead to inaccurate population growth and demographic trait predictions. I then introduce mpmsim, an R package for robust simulation and error propagation in age and stage-based MPMs. The package thus enables researchers to test hypotheses and explore uncertainty in varied demographic scenarios. Its applications include assessing the impact of sampling error on transition rates, exploring demographic trait variations, and

examining life history influences on outcomes. mpmsim is a valuable contribution to the R toolbox, bolstering the computational tools available to population biologists.

Fine-scale variation in gut microbiome in the pied flycatcher in central Spain

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The gut microbiome is a main mediator of life-history traits in animals and performs essential functions that allow hosts to exploit novel niches. However, variation in microbiomes within vertebrate species is poorly understood. We used 16S rRNA gene sequencing to describe the gut microbiome of a passerine bird, focusing on small-scale differences in bacterial composition and relative abundance between its natural habitat (oakwood) and a newly created habitat (pinewood) located 1 km apart. We found that oakwood birds showed a higher abundance of bacterial taxa, without sex or age differences. Oakwood birds had a higher abundance of bacteria with metabolite precursor and energy generation pathways, while pinewood birds had an increase in bacteria with the L-alanine biosynthesis and pentose phosphate pathways. Our study improves our understanding of the gut microbiome composition in birds and shows that habitat, at a small scale, is a key modulator of avian gut microbiome composition.

Evolution in abiotic environments shapes species coexistence

Inês Fragata, cE3c - Center for Ecology, Evolution and Environmental Changes & CHANGE - Global Change and Sustainability Institute, Departamento Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Portugal/ Diogo Prino-Godinho, cE3c - Center for Ecology, Evolution and Environmental Changes & CHANGE - Global Change and Sustainability Institute, Departamento Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Portugal/ Leonor R. Rodrigues, cE3c - Center for Ecology, Evolution and Environmental Changes & CHANGE - Global Change and Sustainability Institute, Departamento Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Portugal/ Miguel A. Cruz, cE3c - Center for Ecology, Evolution and Environmental Changes & CHANGE - Global Change and Sustainability Institute, Departamento Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Portugal/ Flore Zélé, Institut des Sciences de l'Evolution (ISEM), CNRS, Department of Biology, University of Montpellier, France/ Oscar Godoy, Instituto Universitario de Investigación Marina (INMAR), Universidad de Cádiz, Puerto Real, Spain/ Sara Magalhães cE3c - Center for Ecology, Evolution and Environmental Changes & CHANGE - Global Change and Sustainability Institute, Departamento Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Portugal

Adaptation to new environments can shape species coexistence through changes in demographic rates and strengths of biotic interactions. However, this hypothesis remains largely untested. To address this, we performed experimental evolution of two sibling herbivorous spider mite species (Tetranychus urticae and T. evansi) feeding on tomato plants grown with low or high cadmium concentrations. A combination of phenotypic analyses with structural stability theory predicted that adaptation of both species to cadmium allow them to coexist. The shift from competitive exclusion to coexistence was due to an increase in niche differences and to a decrease of fitness differences. We validated these predictions experimentally in both environments. Our study highlights that evolution of single species in a new environment, even in the absence of interspecific competitors, shape species coexistence.

Adaptation to heat via changes in life history deepens the agricultural impact of widespread insect pest

Estelle Burc, Agronomy Institute Rennes-Angers / Camille Girard-Tercieux, AMAP, University of Montpellier / Moa Metz, Animal Physiology, Norwegian University of Science and Technology / Elise Cazaux, Ecole Nationale Supérieure Agronomique de Toulouse / Julian Baur, Animal Ecology, Uppsala University / Alex Hart, Animal Ecology, Uppsala University / Alex Rego, Animal Ecology, Uppsala University / Mareike Koppik, Animal Ecology, University of Halle / David Berger, Animal Ecology, Uppsala University

Current models predicting the spread of pest species under climate change rely heavily on ecological and environmental data but often neglect the role of genetic adaptation. Populations may respond differently to changes in their environment, by plasticity or evolution, optimising life history traits according to local conditions

- which can affect their impact on agriculture. We surveyed life history adaptation and its molecular underpinnings in experimental lines of the seed beetle, Callosobruchus maculatus, evolved at different temperatures. The lines adapted to high temperature had evolved an almost doubling of their agricultural impact, which could be explained by evolved changes in life history traits and gene expression. These results demonstrate the critical role that life history evolution plays in species' ranges and agricultural impacts.

Terrestrial greening and coastal browning delay spring bloom and fish spawning

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In temperate and Arctic areas, land-use change together with a warmer and wetter climate promote plant and forest growth making freshwaters browner as more degraded plant-litter end up as coloured dissolved organic matter. Although freshwater drain to the coast, the downstream consequences in coastal marine ecosystems are poorly understood. Here, we propose that a century of afforestation in Northern Europe has caused more than a month delay in spawning time for the Northeast Atlantic cod. The two are connected through a cascade of physical and biological processes, starting with plant growth on land moving through browner lakes and rivers causing decreased light penetration in coastal waters that postpone the phytoplankton spring bloom and culminate in an adaptive adjustment of spawning time for the cod.

Session 6 -- Effects of anthropogenic land-use changes on ecology and evolution

13th March 2024 - Day 1 / 13:55 / Kerstinsalen, AF-Borgen

The effects of climate and land use change on population persistence of a red-listed plant species in Finland

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Climate change alters environmental conditions across the globe, forcing species to either disperse or adjust to persist. However, the loss, fragmentation, and degradation of habitats induced by land use change drives species' populations to become smaller and more isolated which may limit their ability to persist. Here, we investigate the impacts of climate and land use change on the persistence of a threatened plant species Calypso bulbosa in Finland. We obtained data from the Finnish Biodiversity Information Facility on 7079 populations and used change in monthly mean temperature and rainfall and in the Human Footprint Index as explanatory variables for the existence and extinction of the populations. Our preliminary results indicate that a stronger increase in monthly rainfall and in human impact was connected to a higher likelihood of the extirpation of a local population underscoring the critical need to address both climate and land use change in conservation strategies.

Vegetation development decades after historical land-use at two levels of habitat fertility in sub-arctic tundra

Eero Myrsky, University of Helsinki / Sari Stark, University of Lapland / Outi Manninen, Natural Resources Institute

Land-use pressure in the north creates a need to understand long-term vegetation development after disturbances. We tested how vegetation development varies depending on habitat fertility after disturbance by historical land-use. We analyzed vegetation and soils in reindeer corrals in northern Fennoscandia that were used between 1800's and 1950's. Infertile sites were located in continental section and

acidic bedrock and fertile sites in sub-continental section and non-acidic bedrock. Graminoid abundance was significantly higher inside the corrals in both habitats, although also evergreen dwarf-shrubs had re-established. Forb abundance was higher inside corrals only in fertile habitat. Also, the number of vascular plant species was higher inside the corrals only in fertile habitat. Soil organic matter stocks remained unchanged. Our findings reveal that disturbance may change the dominant plant functional type independent on fertility, but have contrasting impacts on diversity.

The influence of human landscape modification and geomorphology on Iberian wolf population genetic structure

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In recent centuries, the expanding human footprint has disrupted landscape connectivity, influencing gene flow and genetic differentiation patterns in wild populations. Previous work on the extant Iberian wolf population revealed high levels of spatial differentiation and limited gene flow among genetically distinct groups, yet the underlying mechanisms remain unclear. A population decline until the 1970s, due to intense persecution, raises the question: Is the current population genetic structure a consequence of landscape changes and human activities or a long-standing genetic feature of the population? Leveraging a temporal genome-wide SNP dataset, we addressed this question using a landscape genomics approach. Results showed that spatial genetic differentiation was present in post-bottleneck wolves but absent in pre-bottleneck wolves. Such a recent phenomenon is likely driven by a synergy of natural and human landscape features, with local and relatively permeable barrier effects.

Impact of light pollution on reproduction in the threespine stickleback

Sini Bäckroos, University of Helsinki / Ulrika Candolin, University of Helsinki

The use of artificial light at night (ALAN) is rapidly growing around the world. Research has so far focused on effects on terrestrial ecosystems, but aquatic ecosystems - and especially coastal ecosystems – are also increasingly affected. The purpose of this project is to assess the effects that ALAN has on the reproductive success of a key species of the Baltic Sea, the threespine stickleback (Gasterosteus aculeatus). The species regulates the abundance of a range of other species, through its consumption of herbivores and by serving as prey. Thus, changes in population dynamics and distribution of the stickleback could have far reaching consequences for the ecosystem. By altering light conditions during the night, we are investigating the impact that ALAN has on reproductive maturation and reproductive behaviour in the stickleback. We are further assessing how these changes influence reproductive success. The initial results from the experiments will be presented.

Grazing impacts on dune wetland plant community biodiversity over a half-century in a replicated long-term experiment.

Jonathan Millett, Loughborough University/Laurence Jones, UK Centre for Ecology and Hydrology/Ciara Dwyer, Lund University/Sally Edmondson.

Dune slacks are wetlands which are part of the coastal dune habitat mosaic. They host particularly diverse wet grassland plant communities, and several rare and threatened species. UK dune slacks are in an unfavourable and deteriorating condition due particularly to land-use change and natural succession. They are therefore a priority for nature recovery and a focus of restoration efforts, particularly using conservation grazing. In 1974 we set up a replicated experiment, excluding grazing mammals from plots at Ainsdale Sand Dunes National Nature Reserve (NNR) in the UK. We have monitored plant community composition over 50 years. Here we present change in the biodiversity of plant communities in response to environmental and management changes. We demonstrate the importance of long-term experiments for understanding nature recovery in the context of environmental variability over decades. Short-term responses do not always predict long-term responses.

Impacts of vegetation diversity on invertebrate fauna and microbial communities on agroecosystems

Paula Thitz University of Helsinki (FIN) / Luiz Domeignoz-Horta INRAE AgroParisTect Palaiseau (FRA) & University of Zürich (CHE) / Rashmi Shrestha University of Helsinki (FIN) / Seraina Cappelli University of Minnesota (USA) & University of Helsinki (FIN) Mikko Tiusanen ETH Zürich (CHE) / Sampsa Malmberg Metsähallitus (FIN) /Juha Mikola Natural Resources Institute (FIN) / Jussi Heinonsalo University of Helsinki (FIN) / Anna-Liisa Laine University of Helsinki (FIN)

Agriculture drives biodiversity loss, but earlier studies show major impacts on ecosystem functioning even with small increases in vegetation diversity. To investigate how vegetation diversity affects the heterotroph communities in grain monocultures, we sampled fauna and microbes from a field experiment where 1–8 undersown cover crops (including N-fixers and deep-rooted species) were grown among barley at different diversity levels (1, 2, 4, and 8 co-occurring species). We use joint species distribution models accounting for phylogeny and potential effects of heterotroph traits (e.g. size, trophic level, habitat). We determine which community (invertebrates, root and soil fungi or bacteria) responds most strongly to undersown diversity and which aspect of diversity (species or functional richness vs. specific species or functions) has the strongest effect on communities. Our preliminary results show that taxonomic groups respond differently to different aspects of plant diversity.

Session 8 -- Evolutionary biology

13th March 2024 - Day 1 / 16:00 / Palaestra A

The phenological landscape and oak-associated food webs

Ayco Tack, Department of Ecology, Environment and Plant sciences, Stockholm University / Jessie Mutz, Ecology & Evolutionary Biology, University of Tennessee

Climate change will have a major effect on organismal phenology, but we know relatively little on how genetic and environmental drivers interact to shape plant phenology and their associated food webs across natural landscapes. We used a common garden heating experiment with grafted oak trees to quantify the relative contributions of genetic and environmental drivers to tree phenology, and long-term field surveys to understand how these drivers shape the natural phenological landscape, and how strongly phenological variation of oaks is reflected in the

associated insect and microbial communities. Overall, these findings give us insights into how climate change will affect the phenology and structure of oak-associated food webs in natural landscapes, and might inform us about climate-resilient plant breeding.

Atlantic herring – hidden biodiversity in the Baltic Sea

Jake Goodall, Department of Medical Biochemistry and Microbiology, Uppsala University, Sweden / Mats Pettersson, Department of Medical Biochemistry and Microbiology, Uppsala University, Sweden / Arianna Cocco, Department of Medical Biochemistry and Microbiology, Uppsala University, Sweden / Lovisa Wennerstrom, Department of Aquatic Resources, Swedish University of Agricultural Sciences, Sweden / Josefine Larsson, Simrishamn Marine Centre, Sweden / Ulf Bergström, Department of Aquatic Resources, Swedish University of Agricultural Sciences, Sweden / Leif Andersson, Department of Medical Biochemistry and Microbiology, Uppsala University, Sweden.

The Atlantic herring (Clupea harengus) is one of the most abundant vertebrates on earth, with an estimated total breeding stock of one trillion. The species has adapted to both marine and brackish environments across the North Atlantic and displays seasonal variation in spawning period. Despite this, the species exhibits minute genetic differentiation at neutral loci, implying gene flow between populations is sufficiently high to eliminate differentiation. Recently, a novel SNP array was developed, allowing for detailed population genetic studies and the discovery of a novel herring ecotype in the Baltic Sea. While maintaining synchronicity in spawn-period with adjacent populations, this ecotype exhibits drastically increased size (~3 times larger) and a putative shift in trophic niche. Here, we discuss research on the genetic profiling of this ecotype across the wider Baltic Sea, focusing on characterizing genomic regions underlying the ecotype using SNP and WGS-based approaches.

Genomic Offset for Rock Ptarmigan in Response to Climate Change

Theodore Squires, University of Akureyri and Uppsala University / Patrik Rödin Mörch, Uppsala University / Jacob Höglund, Uppsala University / Kristinn Pétur Magnússon, University of Akureyri and the Icelandic Institute of Natural History

In the face of ongoing global climate change organisms must rely on standing genetic diversity for adaptation. To this end, there is a conservation imperative for understanding the genetic adaptability of species and populations. Using whole genome re-sequencing data we study the effects of climate influenced declines in effective population size on the accumulation of deleterious mutations and the response to future climate change in populations of a cold-adapted avian species from the Holarctic: the Rock Ptarmigan (Lagopus muta). We reconstruct the demographic histories of seven populations and determine their nucleotide

diversity, past and present inbreeding, and mutation load. Genomic vulnerability to future climate change scenarios (also known as offset) is predicted for the populations. We show that relatively small and isolated populations have reduced nucleotide diversity, higher signatures of past inbreeding, higher genomic offset, and higher estimates of mutation load.

Limited expression plasticity in highly specialized flies evolving to exploit a novel host plant

Rachel A. Steward, Lund University, Lund, Sweden /Jesús Ortega Giménez, Lund University, Lund, Sweden & Cavanilles Institute of Biodiversity and Evolutionary Biology, Universidad de Valencia, Paterna, Spain / Shruti Choudhary, Umeå Plant Science Centre, Umeå, Sweden/ Su Yi, Lund University, Lund, Sweden / Olivier van Aken, Lund University, Lund, Sweden / Anna Runemark, Lund University, Lund, Sweden

Regulation of gene expression enables organisms to respond plastically to their environments, but the consequences of expression plasticity for adaptation and speciation remain unclear. We investigate constitutive and plastic gene expression differences involved in colonization of a novel niche by the fly Tephritis conura. Larvae of two T. conura specialialist ecotypes have extensive expression differences when reared on their preferred host. However, plasticity in response to cross-fostering to a novel host was low, especially in the derived ecotype. Transcriptional plasticity in the ancestral ecotype was largely related to a slowed life history when feeding on the wrong host. Interestingly, genes that were constitutively differentially expressed between host ecotypes were more likely to be located within a highly divergent, putative inversion that is segregating between these incipient species.

The relative importance of variation in deterministic and stochastic processes in the repeatability of fitness evolution

Karen Bisschop, KU Leuven & Ghent University & Lund University & Origins Center / Thomas, Blankers, University of Amsterdam & Origins Center / Meike T., Wortel, University of Amsterdam / Ken, Kraaijeveld, University of Applied Sciences Leiden / Janine, Mariën, VU Amsterdam / Martijn, Egas, University of Groningen / Jacintha, Ellers, VU Amsterdam / Astrid T., Groot, University of Amsterdam / Marcel E., Visser, Netherlands Institute of Ecology

To predict evolutionary responses, it is essential to understand which factors contribute to the repeatability of evolutionary change. Studies often focus on the relative importance of deterministic (e.g. selection) and stochastic (e.g. drift) processes, where selection should be more predictable than drift. We know however little about how variation in these processes influences the repeatability of evolution. Here, we replicated an evolution experiment where C. elegans was exposed to a new resource across five institutes. We first determined whether a higher fitness evolves under the new conditions. We then tested the relative importance of the uncertainty in selective regimes (differences between labs) and

fundamental uncertainty (differences within labs between treatments) in shaping end point repeatability. We found that the most important factor was the uncertainty in selective regimes, underscoring the need for repeatability when drawing conclusions from experimental evolution.

Whole genome analyses of archival specimens to understand demography and thermal adaptations in a wild fish population

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Using whole genome sequencing data from 222 archival bone and fresh muscle specimens of European perch (Perca fluviatilis), we investigate the genetic consequences of long-term warming. The specimens were collected from 1972 to 2022 in a system where one population has been subjected to substantial warming since 1980, while the other adjacent population experiencing natural thermal regime in parallel. The unique aspects of this system are: (1) ecosystem level experimental set-up: one heated and one 'control' population; (2) the 5-10 °C difference in water temperature enabling us to strongly infer that any observed differences between populations should have been caused by warming. We analyze SNPs from these populations and apply allele frequency-based analysis to study selective sweeps among populations and over time. We discuss possible causes of genetic differentiation, and the potential of fish thermal adaptation to long-term warming on the level of molecular mechanisms.

Session 9 -- EEF session: Ecology meets evolution

13th March 2024 - Day 1 / 16:00 / Palaestra B

Sex-specific fitness of large sex chromosomes under extreme demographic scenarios

Simon Jacobsen Ellerstrand, Lund University / Bengt Hansson, Lund University

When sex chromosomes evolve, one chromosome is permanently fixed in one sex and cease to recombine. Inefficient selection in the absence of recombination eventually leads to degeneration and loss of genes on this sex-limited chromosome. While old and degenerated sex chromosomes are associated with reduced fitness in the heterogametic sex through haploid expression of genes, young sex chromosomes may potentially boost fitness through inflated functional heterozygosity. Here, we study the fitness of sex chromosomes in two Alauda lark species. These species share the largest known avian sex chromosomes formed by several chromosomal fusions of different age. However, they differ widely in demographic history with one being continental and one a severely bottlenecked island endemic. The results demonstrate how the age of sex chromosomes influences sex-specific fitness under extreme demographic scenarios and highlight the importance of the sex determination system in conservation management.

Effects of the environment and individual age on predator avoidance in the Green Tortoise Beetle.

Erica Winslott, Lund University / Kristina Karlsson-Green, SLU Alnarp / Maja Tarka, Lund University

One strategy, that is used by multiple species to avoid a predator attack, is to drop headlong to the ground from an elevated position. Dropping can be costly; the landing site might have a dangerous substrate, other predators, or be distant from a food source. Due to these costs, individuals may choose between different predator avoidance behaviors, depending on e.g., environmental factors or their age.

The green tortoise beetle has two predator avoidance behaviors: dropping to the ground from their host plant or staying still and ducking under their prothorax and elytra. We tracked the behavior of individual beetles in multiple wild free-ranging populations. Here we present how the predator avoidance behavior varies between and within populations, depending on ecological factors such as the landing site and the age of individuals.

This study investigates how natural selection and ecology interacts in wild populations and drives adaptations to predator attacks.

Fluctuating environments and context-dependent pre-mating isolation in the early stages of population divergence

Sofie Nilén, Department of Biology, Lund University / Anna Runemark, Department of Biology, Lund University / Erik Svensson, Department of Biology, Lund University

Understanding the evolution of premating isolation in the early stages of population divergence is a major challenge. Context-dependent mate preferences can influence both population fitness and drive evolutionary change and population divergence. Here, studied premating isolation through quantifying female mate preferences for resident and immigrant males within and between populations of a colour polymorphic insect. Closely located populations differ in densities, female fecundity and community composition. Females showed context-dependent mate preferences: in a high-density year they preferred immigrant males, whereas in a low-density year, this preference was reversed, and females instead preferred resident males. We suggest that context-dependent female mate preferences are shaped by variation in male density between years and that the intensity of sexual conflict causes shifts in the sign and magnitude of premating isolation between populations.

Is there a difference in prezygotic isolation between populations of Drosophila melanogaster?

Katrine Lund-Hansen, Lund University / Olivier Brisset, Lund University / Jessica Abbott, Lund University

Despite strong pre- and postzygotic barriers, it is possible for Drosophila melanogaster to reproduce with its closest relative Drosophila simulans in the lab. However, there could be differences in the ability to species mate discrimination between populations based on previous population history, and thereby a variance in the strength of the prezygotic barriers. We investigated therefore courtship and mating frequencies between D. melanogaster females from five distinct populations from around the world and D. simulans males. We found no significant difference between the five D. melanogaster populations in responds to D. simulans males' mating behaviour. However, we found that both sexes showed very strong prezygotic barriers, which goes against the common notion that males will mate indiscriminately, including even with heterospecific females.

Nutrient landscape shapes the transition between unicellular and multicellular green algae

Qinyang Li, Lund University / Maria Svensson-Coelho, Lund University / Karin Rengefors, Lund University / Charlie Cornwallis, Lund University

The evolution of obligate multicellularity marks one of the major transitions in the history of life. Yet most species remain unicellular or facultatively multicellular. Understanding the ecological conditions that favour multicellularity is key to explaining the co-existence and transition between unicellular and multicellular species. Here we use 16 freshwater green algae to experimentally test if multicellularity is an adaptation to different nutrient niches. Using phylogenetic comparative analyses, we show that 1, multicellular and unicellular algae differ in their growth-survival trade-offs. 2, nutrients increased the degree of multicellularity within a species and such increased degree of multicellularity did not confer a fitness cost. These results show that unicellular and multicellular algae are adapted to different nutritional niches, but multicellularity can also vary within a species due to environmental conditions, creating phenotypic variations with adaptive potentials.

On a reciprocal role of ecology and evolution for evolutionary predictions

Masahito Tsuboi, Lund University

Although biology has often thought to be inherently unpredictable, the past decade has seen major advances in research on predictions in ecological and evolutionary research. There is a growing excitements that ecological and evolutionary processes are sometimes predictable. However, it remains unclear how ecology contributes to evolutionary prediction, and vice versa. In my presentation, I will propose a reciprocal role of ecology and evolution for making evolutionary predictions based on the model of phenotypic evolution on moving adaptive optima. Using wing morphology of two damselfly species–Ischnura elegans and Enallagma cyathigerum–as a model system, I will empirically show how the reciprocal role of ecology and evolution can be examined, and how to related obtained insights to the pattern of phenotypic divergence across populations and species conceptually. In closing, I highlight several irreplaceable roles of ecologists for evolutionary prediction.

Session 10 -- Pollination

13th March 2024 - Day 1 / 16:00 / Kerstinsalen, AF-Borgen

Does floral traits mechanically limit buzz-pollinating bees?

Karin Alexandersson Ros, Department of Ecology and Genetics, Plant Ecology and Evolution, Uppsala University

Pollen release in buzz-pollinated flowers (flowers requiring bee vibrations to release pollen) is expected to be influenced by biomechanical floral properties. Yet, few studies have investigated how these properties affect pollen release. In this study, we manipulate a key biomechanical property, anther stiffness, to determine its effect on pollen release.

Using Solanum rostratum we experimentally increased anther stiffness by applying a thin metal rod to the anther filament. We exposed control and manipulated flowers to Bombus terrestris and measured pollen release. In this ongoing study, we expect anther stiffness to affect pollen release, with stiffer anthers predicted to need a higher amplitude vibration to release the same amount of pollen as a natural anther.

The extent to which anther stiffness influences pollen release might hence affect which pollinators are capable of efficiently pollinating S.rostratum and could subsequently be part of shaping plant-pollinator interactions.

The impact of simulated heatwaves on bumblebee pollination effectiveness

Guadalupe Sepúlveda-Rodríguez, Department of Zoology, Stockholm University/ Priscila Araújo, Department of Zoology, Stockholm University/ Anna T. Renner, Department of Zoology, Stockholm University/ Maxence Gérard, Department of Zoology, Stockholm University and Laboratory of Zoology, Research Institute for Biosciences, University of Mons/ Mario Vallejo-Marín, Department of Ecology and Genetics, Uppsala University/ Emily Baird, Department of Zoology, Stockholm University.

The frequency and magnitude of heatwave events is increasing. While elevated environmental temperature is known to impact flight performance and foraging behavior in bumblebees, the direct effects of heatwaves on bumblebee pollination effectiveness are unknown. Here, we investigated the effect of simulated heatwaves on the behavior and pollination effectiveness of bumblebees foraging on Solanum rostratum. The bees experienced optimal conditions (4 d @ 26 ˚ C during the day, 20 ˚ C during the night), followed by a heatwave (3 d @ 32 ˚ C during the day, 26 ˚ C during the night). We recorded bee behaviour and estimated both fruit and seed set

of plants pollinated in the different treatments. During the heatwave treatment, bumblebees performed more foraging trips and visited more flowers but the plants they pollinated had a lower fruit and seed set. Our results suggest that heatwaves affect bumblebee pollination behavior and that this impairs plant reproduction.

Joint evolution of pollen longevity and mating system: Predictions and empirical tests

Laura S. Hildesheim, Lund University/ Øystein Opedal, Lund University

Changing pollinator communities can delay pollination and result in fertilization with older pollen. Pollen longevity and mating system may evolve jointly due to the pollinator environment. Sequential pollen presentation within blossoms may alleviate the cost of ageing pollen by continuously presenting fresh pollen. We study the joint evolution of pollen longevity and mating system in selfing and outcrossing taxa of Dalechampia scandens. We quantify the cost of old pollen on seed set and the role of pollen presentation schedules in alleviating the cost of delayed pollination. Pollen longevity was shortest in selfing, and longer in outcrossing, taxa. Old pollen lowered seed quantity, but not quality. Sequential pollen presentation resulted in stable high seed set. Pollen longevity evolves jointly with the mating system due to the pollinator environment. Pollen age effects mediate the ability to cope with delayed pollination and need to be considered in the study of pollinator declines.

Unravelling patterns and drivers of pollen longevity across diverse plant species and environments

Louise Winther, Section of Organismal Biology, University of Copenhagen / Conny Bruun Asmussen Lange, Section of Organismal Biology, University of Copenhagen / Sergey Rosbakh, Section of Organismal Biology, University of Copenhagen

Viable pollen is important for plant breeding and cultivation, pollination biology, conservation, and gene bank storage. For successful fertilization, both in and ex situ, pollen must remain viable for a period, varying between mere minutes to several months. However, the knowledge of factors affecting pollen longevity remains limited, despite its pivotal role. In a comprehensive meta-analysis encompassing approximately 300 wild and cultivated plant species across the globe, we aim at unraveling the complexities of pollen longevity. We first estimate the degree of intra- and interspecific variation in pollen longevity. Second, we test whether the longevity of pollen is affected by phylogenetic relatedness, the anatomy and physiology of pollen grains, pollination methods, and ecological factors. The analysis and the underlying pollen longevity data will be made available as an online database to be used by researchers, breeders, and conservationists in their respective fields.

Effects of pollinator declines on grassland plant communities in two experimental platforms

Theresia Krausl, Lunds Universitet / Veronica Hederström, Lunds Universitet / Yuanyuan Quan, Lunds Universitet / Yann Clough, Lunds Universitet

In Europe, semi-natural grasslands are among the most diverse ecosystems. Pollinator availability in grasslands has been shown to be linked to shifts in plant community composition, but little is known about how the ongoing pollinator declines could be driving these changes. To investigate this, we set up two multi-year experimental platforms. We studied plant community composition, reproductive success and floral resources both in the field along a pollination intensity gradient with an added pollinator reduction treatment and in a controlled multi-factorial mesocosm experiment within an artificially sown grassland. Our first results give insight into phenological changes in a pollinator deprived environment as well as how different plant functional groups react to pollinator declines. Anticipating plant community changes brought about by pollinator declines is an important prerequisite for targeted conservation measures to preserve species diversity in our most precious ecosystems.

A mosaic of local pollinator assemblages underlies floral trait divergence in a pollination-generalized plant.

Felipe Torres-Vanegas / Vanda Temesvári / Magne Friberg / Øystein H. Opedal / Department of Biology, Biodiversity Unit, Lund University. Lund, Sweden. SE 223 62.

Studies that relate geographical variation in floral traits to the distinct regimes of phenotypic selection exerted by the local pollinator assemblage are fundamental to understand the interplay between microevolution and macroevolution. Here, we evaluated whether geographical variation in the composition of the local pollinator assemblage can establish distinct regimes of phenotypic selection and underlie the patterns of divergence in floral traits of Viscaria vulgaris. We detected geographical variation in the composition of the local pollinator assemblage. Despite generalized plant-pollinator interactions, we detected that the observed variation in floral traits was associated with divergence in the composition of the local pollinator assemblage. We argue that generalized plant-pollinator interactions can exert phenotypic selection on floral traits and that distinct local pollinator assemblages can underlie the patterns of divergence in floral traits.

Session 11 -- Hans Kristianssons mini-symposium: Open session zoology

14th March 2024 - Day 2 / 10:00 / Stora Salen, AF-Borgen

Differential patterns of gut microbial diversity along urbanisation gradients in a native-invasive vertebrate system

Claudia Romeo, University of Copenhagen – Denmark/Nanna Gaun, University of Copenhagen – Denmark/Aoife Leonard, University of Copenhagen – Denmark/Claudia Tranquillo, Università degli Studi dell'Insubria, Italy/Lucas A. Wauters, Università degli Studi dell'Insubria, Italy/ Antton Alberdi, University of Copenhagen - Denmark

The gut microbiota is a driver of several key phenotypic traits of vertebrates and is thus hypothesised to modulate their adaptation capacity. We examined variation in gut microbial communities of native red squirrels (Sciurus vulgaris) and invasive grey squirrels (S. carolinensis) along replicated natural-urban gradients. Overall, α-diversity of gut microbiota was consistently higher in grey than in red squirrels and the degree of urbanization did not ultimately affect the invasive species' microbial functionality, which remained high independently of spatial or temporal gradients. Conversely, functional diversity of red squirrels' gut microbiota decreased strongly with urbanization and varied seasonally. Our results suggest that the grey squirrel has a higher adaptation capacity compared to its native congener, which instead sometimes shows signs of dysbiosis in urban habitats, probably induced by increased physiological stress and/or reduced access to high-quality food resources.

Evolution of female ornamentation in dance flies: are valuable gifts worth dressing up for?

Varpu Pärssinen, University of Gothenburg / Luc Bussière, University of Gothenburg / R. Axel W. Wiberg, Stockholm University / Charlotta Kvarnemo, University of Gothenburg

Ornaments are thought to be rare in female animals, because the potential increase in female fitness is rarely worth the cost of ornamentation. Three genera of dance flies (Empidinae) are characterized by two traits: nuptial gifts and female ornamentation. In some species of Empidinae, males present an edible prey item to the female upon mating, while some species use an inedible token gift or no gift at all. The level of female ornamentation also varies between species. Nutrition gained from the edible nuptial gifts may be able to compensate for functional constraints of ornamentation in females. We conducted a phylogenetic analysis on the evolution of female ornamentation in Empidinae using previously published

genomic sequences, as well as literature on nuptial gifts and female ornamentation. We predict that female ornamentation has evolved more consistently in species that also use a high-value nuptial gift in mating.

Does hard work pay off? The trade-off between Great tits' present and future reproductive success under climate change

Ventura, Sofia / Nilsson, Jan-Åke / Hegemann, Arne / Broggi, Juli

Insectivorous birds' breeding success depends on how well the laying date is synchronized with prey peaks. Such a crucial equilibrium is threatened by climate-change. Warmer springs are triggering early budburst, and caterpillar phenology seems to respond accordingly. Yet, bird phenology appears to be less plastic. If bird phenology lags behind that of their main prey, the period of highest food demand from the nestlings will eventually fail to match caterpillar peaks. This poses the question of how birds will respond to limited food supply, and whether present and future reproductive success will be involved in a trade-off. This study focuses on a Great tit (Parus major) population breeding in a coniferous forest south of Vombsjön, in Southern Sweden. The tits were exposed to brood size manipulations to simulate variation in breeding effort. The constitutive immune system was used as a proxy for future reproductive success in the adults and for offspring quality in the nestlings.

Optimal time of migration in trout is a result of timing-dependent future growth and predation risk

Dominique Stalder / Department of Fish Ecology & Evolution, EAWAG, Centre for Ecology, Evolution and Biogeochemistry, 6047 Kastanienbaum, Switzerland / Department of Aquatic Ecology & Evolution, Institute of Ecology and Evolution, University of Bern, 3012 Bern, Switzerland / Jakob Brodersen / Department of Fish Ecology & Evolution, EAWAG, Centre for Ecology, Evolution and Biogeochemistry, 6047 Kastanienbaum, Switzerland / Department of Aquatic Ecology & Evolution, Institute of Ecology and Evolution, University of Bern, 3012 Bern, Switzerland

Most migratory animals take advantage of seasonally varying resource availabilities in alternative habitats to increase their evolutionary fitness. Because natal and migratory habitats differ not only in resource availability, but also in other seasonally varying factors such as predation risk, the exact mechanisms shaping optimal migration timing are often poorly understood. Using data from more than 20'000 trout tagged across eight years, we examine how timing of away migration influences 1) the likelihood of successful return migration to the spawning habitat and 2) the growth in the migratory environment. We find that individuals migrating at larger size and later in the season are more likely to survive migration and return to their natal streams. However, regardless of size at away migration, earlier migrants are larger upon return and are thus expected to have higher reproductive output. Our findings elucidate the trade-offs individuals face in respect to timing of migration.

Sex makes the difference: Immune function predicts local survival in a wild bird species, but the effect depends on sex

Malin V. Klumpp, Department of Biology, Lund University, Lund, Sweden/ Arne Hegemann, Department of Biology, Lund University, Lund, Sweden

Individual variation in survival is common in populations, and the ability to develop and maintain high immune function is thought to be crucial for a high survival probability in wildlife. Yet, only few studies have investigated the relationship between innate immune function and survival in wild animals. Here, we examined four measures of constitutive innate immune function for their ability to predict annual local survival probability in Common Blackbirds (Turdus merula). Contrary to our predictions, haemolysis, haemagglutination and haptoglobin concentrations did not reliably predict local survival probability. However, local survival was related to bacterial killing ability (BKA), and the direction of this effect depended on sex. In females, BKA was positively correlated with local survival, whereas the relationship was negative in males. Our results suggest that different sexes may have different strategies in investing in the immune system to maximize their survival.

Early-life sicknesses as drivers of animal movement later in life

Arne Hegemann, Department of Biology, Lund University, arne.hegemann@biol.lu.se

Movement, including migration and dispersal, is fundamental for life. Large and sometimes surprising variation in movement between individuals is well documented, but what causes this variation? Why do individuals move the way they do? The mechanisms underlying migration ontogeny and natal dispersal represent a major knowledge gap in our understanding of the ecology and evolution of animals. Infections, common during early life, have been proposed as drivers of migration ontogeny and natal dispersal. However, unequivocal evidence is missing. Here, I present intriguing data from a proof-of-concept study suggesting that experimentally induced early-life sicknesses, via changes in morphology (i.e. size) and physiology (e.g. immune function), may result in reduced local movements and shorter migration during adulthood. This opens up exciting possibilities to generate a new understanding of the mechanisms that shape movement across an animal's life span and the consequences for fitness.

Predicting foraging trips of the world's seabirds

Quentin Queiros Department of Aquatic Resources, Swedish University of Agricultural Science, 756 51 Uppsala, Sweden/Carlsen A.A. Department of Aquatic Resources, Swedish University of Agricultural Science, 756 51 Uppsala, Sweden/ Hentati-Sundberg J. Department of Aquatic Resources, Swedish University of Agricultural Science, 756 51 Uppsala, Sweden

Seabirds are central-place foragers during breeding, commuting long distances between colonies and feeding areas. Understanding their foraging areas is essential for informing spatial management measures to protect habitats and prey populations. While foraging of several seabirds has been intensively studied, knowledge on two-thirds of the world's seabird species is still lacking. Here, we propose to calculate species-specific foraging features for well-studied species and use those to predict these features for understudied species. By compiling 350 datasets from two global seabird tracking databases (>14,000 individuals), we have estimated the foraging features for 87 seabird species. Then, we have developed phylogenetically informed models by including morphological traits and seabird colony size as explanatory variables. The results will be integrated into a bio-energetic model to calculate energy requirements of the world's seabirds and estimate their prey requirements.

Capercaillie and effects of predation on reproduction: an experimental test.

Lars Hillström, University of Gävle, Sweden/ Klara Menzikova, University of Brno, Czech Republic/ Daniel Lake, Svartbäcksgatan 50 C, 753 33 Uppsala, Sweden/ Antonio Carpio, Instituto de Investigación en Recursos Cinegéticos, IREC, University of Castilla-La Mancha, Spain.

Capercaille (Tetrao urogallus), is considered an umbrella species and is declining over much of its range, fragmentation and/or nest predation seems main causes of this decline. We investigated potential predators, mammals and birds' effects on nests of the Capercaille. We used chicken eggs filled with plaster painted with small brown dots to mimic the original eggs. The location of the plots (n=14) was on sites within Capercaillie lek territories, and where rooting of wild boar was either recorded (N=6) or not recorded (N=8) during 2019 and 2022. In each nest four eggs were placed, two filled with plaster and two fresh chicken eggs (seven nests per plot). There was a significant difference in predation rate between years ($p<0.0003$, $F= 14.50$), and how many people were present when the eggs were put out in the plots ($p = 0.046$, $F = 3.19$), but not between areas in relation to wild boar presence ($p= 0.16$, $F = 1.96$). The importance of human factor in experimental studies will be discussed.

Session 12 -- Ecological and evolutionary responses to a changing environment

14th March 2024 - Day 2 / 10:00 / Palaestra A

Winters restrict a climate change-driven butterfly range expansion despite rapid evolution of two seasonal timing traits

Mats Ittonen, Department of Zoology, Stockholm University, Sweden / Matthew E. Nielsen, Department of Zoology, Stockholm University, Sweden / Isabelle Siemers, Department of Zoology, Stockholm University, Sweden / Magne Friberg, Department of Biology, Lund University, Sweden / Karl Gotthard, Department of Zoology, Stockholm University, Sweden

Climate change pushes species polewards and upwards. However, the proximate drivers of range expansions vary, and it is unclear how evolution may facilitate climate change-driven range expansions. We translocated range-interior and range-margin individuals of the wall brown butterfly – which has expanded northwards in 2000–2020 – to three field sites in Sweden: a range interior site, a range margin site, and a site north of the species' current range. Winter survival was minimal beyond the range and probably sets the range limit. We show that both growth rate and daylength thresholds for winter dormancy (diapause) induction have evolved in range margin populations, but that winter survival has not. Thus, seasonal timing traits can evolve rapidly, but such evolution seems unimportant for a range expansion driven by winter warming. We complement our field experiments with genomics and laboratory experiments, allowing robust inferences of eco-evolutionary dynamics during range expansions.

An indicator of population welfare based on survival rates to monitor demographic consequences of changing environments

Morgane Tidière, University of Southern Denmark & Species360

Can we perpetually extend the lifespan of a species, or does an inherent limit exist, irrespective of environmental quality? Analyzing changes in life expectancy and lifespan equality – a pair of well-established metrics reflecting population well-being in both humans and other long-lived mammals – in relation to the environmental conditions, we seek to ascertain the presence of a sex- and species-specific maximum potential for longevity. Employing the Zoological Information Management System (ZIMS, by Species360), compiling demographic data from zoos since the mid-1800s, and published sex-specific life tables from wild populations for 13 species, our goal is to enhance understanding of the complex interplay between environmental change, evolutionary history, and demographic

parameters. This research not only advances fundamental knowledge but also serves as a practical tool for optimizing resource allocation in conservation and research, ensuring efficient population management.

Climate change and potential door-knockers: an Arctic horizon scan of vascular plant species.

Tor Henrik Ulsted Faculty of Natural Sciences NTNU/James D. M. Speed Department of Natural History NTNU University Museum/Kristine Bakke Westergaard Department of Natural History NTNU University Museum

The Arctic is incredibly vulnerable to climate change and human activities, threatening its biodiversity and ecosystem services. An emerging challenge is the spread of non-native plant species that may alter Arctic ecosystems. However, little is known about which plant species worldwide could potentially naturalize in the Arctic region. This study addresses this knowledge gap with horizon scanning of the Global Naturalized Alien Flora (GloNAF). We quantify climatic niche overlaps using an n-dimensional hyperspace and kernel density distribution model to identify and map potential door-knocker vascular plant species in the Arctic under current and future climate scenarios. Our results can help identify and prioritize high-risk species and areas and hence implement prevention, early detection, and control measures by supplying a comprehensive and updated list of potential door-knocker vascular plant species and their distribution across the changing Arctic.

The spruce bark beetle as a climate engineer

Caroline Greiser / Stockholm University / Ian Brown/ Stockholm University / Philipp Lehmann/ Greifswald University

We showcase an ecological consequence of climate change feeding back to local climate change. Spruce bark beetle outbreaks have increased, tied to a warming climate. Bark beetles are expected to change forest microclimate due to changes in canopy cover, albedo, wind patterns, and evaporation. We explored the effect of bark beetle attacks on forest microclimate using two approaches. Firstly, we measured understory microclimate with small consumer-grade loggers in 30 Swedish forest stands along an attack rate gradient. Secondly, we created maps of canopy temperature over the logger areas using multispectral drone scanning. We contrasted canopy temperatures of healthy spruce trees with those attacked by beetles. We found warmer daytime and cooler nighttime summer temperatures in attacked compared to healthy stands, but with smaller effect sizes than expected, indicating that even dead forest stands may function as thermal buffers for understory biodiversity.

Genomic basis of melanin-associated phenotypes suggests colour-specific environmental adaptations in tawny owls.

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Here we explore the molecular basis of melanin coloration and expected co-variation at the molecular level in the melanin-based, colour polymorphic system of the tawny owl (Strix aluco). For that, we assembled the first draft genome of the species against which we mapped ddRADseq reads from 220 grey and 150 brown morphs - representing 10 years of pedigree data from a population in Southern Finland - and explored genome-wide associations with colour phenotype. Our results revealed putative molecular signatures of cold adaptation strongly associated with the grey phenotype, namely a non-synonymous substitution in MCHR1, plus 2 substitutions in non-coding regions of FTCD and FAM135A whose genotype combinations obtained a predictive power of up to 100% (predicting grey colour). Our results suggest a molecular basis of cold environment adaptations predicted to be grey-morph specific and reveal part of the molecular machinery of melanin-associated phenotypes

Adaptive sperm in an invasive fish – evolution in real time

Charlotta Kvarnemo, Dept of Biological and Environmental Sciences, University of Gothenburg/Leon Green, Dept of Biological and Environmental Sciences, University of Gothenburg

Fertilization is a sensitive life-history stage, which can be detrimentally affected by the environment. The round goby is native to the Black Sea region. Since its introduction to the brackish Baltic Sea in 1990, the species has spread towards both higher and lower salinity. How does this invasive fish with external fertilization manage to spread into new salinities? We show that ancestry of the source population is important, with ancestral freshwater genotypes invading Rhine and Danube, while brackish genotypes dominate the ongoing spread into higher salinities. We also find clear signs of ongoing local adaptation. Sampling fish from high and low salinity expansion fronts within the Baltic Sea, and we find that peak sperm velocity matches local salinity conditions better the older the population is, but no effect of acclimation. Thus, our results indicate that this invasive fish is rapidly adapting to new salinities, possibly allowing a future expansion into fully marine waters.

Transgenerational effects of ageing on offspring life histories

Patrik Karell, Department of Ecology and Genetics, Uppsala University, Department of Biology, Lund University

Transgenerational ageing processes are often neglected in studies of ageing, although the Lansing effect – offspring of older parents have shorter life span – has been documented in a wide variety of taxa. Using 46 years of pedigree data from a colour polymorphic population of Finnish tawny owls I assess the pattern of the Lansing effect. Grey tawny owls live longer than the brown and have a slower rate of telomere shortening than the brown. Hence, a faster rate of ageing in brown tawny owls is expected to be linked with a faster decrease in offspring lifespan. I predict that parental age has a morph-specific effect on offspring life span where the negative effect of being born from older parents is stronger in brown than in grey morphs. I discuss the results in the light of colour morph variation in ageing processes and the mechanisms by which ageing effects may transfer across generations.

Parasite transmission in Svalbard reindeer in a changing climate: experimental study on dispersal of a reindeer parasite

Tirza Moerman, Norwegian University of Life Sciences & The University Centre in Svalbard

Changing environments are expected to impact parasites that can negatively affect hosts. Parasite dispersal under changing abiotic regimes is a vital factor in understanding parasite transmission. We conducted two experimental studies on reindeer parasite dispersal in which we tested the hypotheses that 1) warm and dry conditions result in parasite movement to deeper soil layers and cold and moist conditions in movement to vegetation where parasites are more likely accessible to the host. 2) parasites actively disperse out and away from faeces but with limited dispersal range. Preliminary results suggest that 1) moisture treatment had a more profound and positive effect on the number of parasites retrieved from soil and vegetation than temperature treatment and 2) parasites could actively disperse from faeces, but only short distances. Understanding parasite dispersal has implications for indicating infection hotspots and understanding parasite-host dynamics under a changing climate.

Session 13 -- Plant biology - open session

14th March 2024 - Day 2 / 10:00 / Palaestra B

Biomass and nutrient dynamics in garden lupine (Lupinus polyphyllus): optimal mowing dates for population control

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In light of declining semi-natural grasslands, road verges serve as vital refuges for plants. Resembling traditional grasslands in management regimes underscores their importance. However, invasive species like garden lupine (Lupinus polyphyllus) threaten this value. Mowing proves most effective for control when the shoot:root ratio is high or below-ground reserves are depleted but seeds haven't matured. This study aims to identify optimal mowing for controlling garden lupine and describe the timing in phenological terms. Lupine plants were collected throughout the growing season, segmented into roots, leaves, and stem + inflorescence, and analyzed for phloem-mobile nutrients (N, P, K, Mg). The nutrients were highly correlated in the roots, and the nutrient contents were lowest during the flowering phase. Therefore, we recommend mowing during this period in the plant's phenology. However, to avoid seed spread, it is advisable to mow during early flowering before seed pods are visible.

Common reed associated microbiome in bioremediation

Elisa Heilmann, University of Oulu, Ecology and Genetics Research Unit, Finland / Kaisa Lehosmaa, University of Oulu, Ecology and Genetics Research Unit, Finland / Saija Ahonen, University of Oulu, Ecology and Genetics Research Unit, Finland / Anna-Maria Pirttilä, University of Oulu, Ecology and Genetics Research Unit, Finland / Anna Liisa Ruotsalainen, University of Oulu, Ecology and Genetics Research Unit, Finland

Utilizing the ability of plants to bind harmful substances from their environment has been researched globally. Plants are capable of binding heavy metals as well as other environmentally harmful substances into their structures, and aid in the remediation of polluted land and water. Along with plants, bacteria and fungi are also utilized in this context. We studied the microbiome of the common reed as well as copper (Cu) and zinc (Zn) concentrations in the plant tissue, at four sites with variable distances to a mining site, using sequencing and metal analysis. The samples were analyzed specific to each plant organ to estimate where the plant stores metals and to find interactions with associated microorganisms. Our results indicate that bacteria associated with metal-rich conditions are more abundant in the common reed near a mining site, potentially aiding the plant in tolerance and

accumulation of heavy metals. Cu and Zn concentrations were the highest in theroots of the plant.

Seasonality patterns in arctic plants and their root microbiome

Leah Kirchhoff, Department of Ecology and Environmental Science, Umeå University, Sweden / Emil Andersen, Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden / Rebekka Gullvåg, Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden / Niki Leblans, Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden / Kaj Lynøe, Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden / Johan Olofsson, Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden/ Ellen Dorrepaal, Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden/ Sara Hallin, Department of Forest Mycology and Plant Pathology; Markmikrobiologi, Swedish University of Agricultural Sciences, Uppsala, Sweden/ Karina Clemmensen Department of Forest Mycology and Plant Pathology; Markmikrobiologi, Swedish University of Agricultural Sciences, Uppsala, Sweden

The vegetation in northern ecosystems is exposed to cold temperatures and snow for large parts of the year. Which is less studied despite evidence of plant activity. However, plants and the root-associated soil microbiome impact carbon and nutrient cycling throughout the year but may show mismatches in seasonality. Such seasonal mismatches due to e.g. climate change-induced shifts in plant or microbial activity might affect biogeochemical cycles. In this project I link aboveground plant traits with belowground plant and microbial characteristics in sub-arctic tundra vegetation throughout the year. The focus is on relations between roots and root-associated bacteria and fungi, and their relative contribution to soil processes. I will present preliminary results from a potted garden experiment examining 12 species measured at six time-points, covering all seasons. The measured variables are aboveground plant traits that will be combined with root traits and bacterial and fungal biomass.

Intraspecific trait variation in dwarf shrubs across coastal, alpine and arctic heathlands

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Dwarf shrubs dominant many heathland ecosystems at high latitudes. However, dwarf-shrubs are underrepresented when modelling how vegetation influences fluxes of carbon, water and energy in land surface models. To create new plant functional types that better represent these important species, we use plant functional traits to explore responses and effects to environmental and biotic interactions, also assessing the extent intraspecific variation. In DURIN, we examine intraspecific variability in plant functional traits focusing on the dwarf shrubs

Calluna vulgaris, Empentrum nigrum, Vaccinium myrtillus and Vaccinium vitis-ideae which were sampled in paired forested and open heathlands located at coastal and inland sites distributed in southern and northern Norway. Understanding the extent of intraspecific trait variation at local and regional scales, will provide insights as to the adaptive potential of these key species, and provide more robust parameters for land surface modelling.

Toxic environment? Comparison of the allelopathic capacity of Empetrum nigrum in Icelandic and other Scandinavian soils

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Following years of livestock exclusion, Icelandic rangelands remain trapped in a severe state of degradation. The dwarf shrub Empetrum nigrum possesses bioactive allelochemicals with the potential to retard ecosystem recovery. While the allelopathic capacity of Scandinavian E. nigrum is recognized, Icelandic E. nigrum populations, and possible influence of volcanic soil is unknown. The allelopathic capacity of Icelandic E. nigrum was measured by LC-MS and accompanying bioassays. We show that Icelandic E. nigrum produce several bioactive bibenzyls, with chemical differences measured between ssp. nigrum and ssp. hermaphroditum. Leaf exudates of both subspecies inhibit seed germination and root elongation of the grass Festuca richardsonii. The allelopathic response remains consistent with soils originating from Iceland, Faroe Islands and Norway, suggesting that allelopathic capacity of E. nigrum is directly linked to its chemical constituents.

The impact of local adaptation versus phenotypic plasticity on the pollen chemistry signal of Pinus sylvestris pollen

Mayke Nieuwkerk, University of Bergen, Norway / Alistair Seddon, University of Bergen, Norway

A key question in determining the reliable use of polyphenolic compounds found in sporopollenin as a proxy for reconstructing past changes in UV-B radiation, is whether variation in the UV-B absorbing compound signal is driven by seasonal changes in UV-B radiation or by genetic factors inherited over the longer term. Here, we investigate the importance of phenotypic plasticity compared to local adaptation on the UAC signal from Pinus sylvestris pollen. Pollen samples were collected from two sites and three populations from an established common garden experiment in Spain. The relative UAC content of the sporopollenin was measured using FTIR spectroscopy and Gas Chromatography Mass Spectrometry and then analyzed using PLS analysis and linear mixed effect modelling. Differences in the UV-B absorbing compound signal were found between the common garden sites and between the populations, concluding that both phenotypic plasticity and local adaptation influence the sporopollenin UAC signal.

Determining the climatic niche of vascular plants in the archipelago of SW Finland

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In the archipelago of SW Finland, the climate changes from the mainland to the open sea. I relate the occurrences of 12 plant species on 2344 islands to temperature and precipitation in early summer and in autumn. I use PCA to find gradients based on the climatic predictors, island area, island topological diversity and exposure. AX1 correlates with the climatic predictors and runs from islands with a high early summer temperature, low autumn temperature and high precipitation to islands with a low early summer temperature and low precipitation. AX2 is linked with island area and island topographical diversity. All 12 species have their distribution shifted to the outer archipelago end of AX1. The distributions of the species along AX1 and AX2 is visualized and predictors that influence the probability of occurrence are discussed. The possibility to outline the climatic niche of the species is discussed, as well as the possibility to use the species as indicators of climate change.

Precision of molecular plant identification in Thy National Park and applicability in biodiversity monitoring

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Coastal sand dunes are dynamic landscapes shaped by wind, water and salt and characterized by a rapid turnover of the habitat types. We explore efficient ways of monitoring biodiversity change in dune dynamics. Molecular plant identification may compliment a trained botanist by prolonging the monitoring season, identify from fragments and add quality. To test the precision of molecular identification we collected a herbarium specimen and leaf material for DNA analyses from 100 plant species. We used rbcL sequences to test the ability of international databases, Genbank and BOLD to retrieve the correct identifications. Less than 50% of the individuals were unambiguously identified to the correct species. However, a barcode gap existed between most species and NJ analyses clustered individuals from same species. We conclude that caution should be exercised when basing plant identification purely on BOLD and GenBank. The high rate of misidentifications will affect biodiversity monitoring.

Session 14 -- Open session 2

14th March 2024 - Day 2 / 10:00 / Kerstinsalen, AF-Borgen

Pesticide use negatively affects bumble bees across European landscapes

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Bees encounter many pesticides in agricultural landscapes and the effects of this landscape exposure on colony growth and development of any bee species remains unknown. Here we show that the many pesticides found in bumble bee-collected pollen are associated with reduced colony performance during crop bloom, especially in simplified landscapes with intensive agricultural practices. Our results from 316 Bombus terrestris colonies at 106 agricultural sites across eight European countries confirm that the regulatory system fails to sufficiently prevent pesticide-related impacts on non-target organisms, even for a eusocial pollinator species in which colony size may buffer against such impacts. These findings support the need for postapproval monitoring of both pesticide exposure and effects to confirm that the regulatory process is sufficiently protective in limiting the collateral environmental damage of agricultural pesticide use.

Spatial connectivity increases ecosystem resilience towards an ongoing regime shift

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Ecosystem regime shifts can have severe ecological consequences, making it a top priority to understand how to make systems more resilient. Theory predicts that spatial connectivity and the local environment interact to shape resilience, but empirical studies are scarce. Here, we use >7000 fish samplings from the Baltic Sea coast to test this prediction in a spatially propagating shift in dominance from predatory fish to an opportunistic mesopredator. After controlling for the influence of the driver (increasing mesopredator densities), we find that predatory fish habitat connectivity increases resilience towards the shift, but only when densities of fish-eating top predators (seals, cormorants) are low. Resilience also increases with temperature, likely through boosted predatory fish growth and recruitment. Our findings confirm theoretical predictions that spatial connectivity and the local environment can act together to shape resilience towards regime shifts.

Fish trait and population changes under multi-generational heating in the wild: adaptations to global warming?

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Observations suggest that climate warming affects fish traits, models that it can alter interactions and population dynamics, and selection experiments show evolutionary trait responses in the lab. Long-term field experiments that can test effects of warming on fish in the wild are, however, rare. We report on trait and

population responses from a warming experiment of a whole coastal ecosystem, lasting multiple fish generations. We combine annual monitoring, since before heating started 43 years ago, of perch (Perca fluviatilis) populations inside and outside of the heated ecosystem, with a reciprocal transplant experiment. We show how warming alters body growth, maturation size, population structure and mortality, but that responses are both size- and sex-specific. Growth and maturation changes increased with heating duration, suggesting evolutionary responses. The transplant experiment also suggests local adaptation, but points to costs of adaptation to ongoing global warming.

Can evolutionary potential help plants survive climate change? Finding patterns in evolvability of Hypericum populations

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To predict the consequences of global change, we need knowledge of the ability of populations to evolve. On the short term, this is driven by the amount of standing genetic variation in the population. There is limited empirical data on evolutionary potential in natural populations, and on how evolutionary potential varies among species and across species distributions. Here, we evaluate and compare evolutionary potential in multiple populations of two Hypericum species, one of them a generalist with a wide geographic distribution, and the other a rare habitat specialist. We utilize manual crossing experiments in a nested half-sibling breeding design and quantitative genetic analyses to estimate evolvabilities (mean-scaled genetic variances) as a proportional measure of evolutionary potential. With such comparisons of evolvability in different types of species and populations, we can begin to understand general patterns in the variation of evolutionary potential in nature.

Apparent survival of white-tailed eagles exposed to wind power in coastal Norway

Brett K. Sandercock, NINA / Espen Lie Dahl, Smøla / Oddmund Kleven, NINA / Roel May, NINA / Torgeir Nygård, NINA / Diego Pavón-Jordán, NINA / Bård G. Stokke, NINA

Renewable energy from wind power is important for mitigation of climate change but risks of collision mortality remain an environmental concern for many birds. We monitored white-tailed eagles (Haliaeetus albicilla) breeding at a coastal island with an established wind park. Smøla supports 48 eagle territories (261 km2) but also

has a 150MW wind park with 68 turbines (15 km2). Productivity averaged 0.59 eaglefledglings per active territory. Eagles at nest sites were identified and sexed by genetic analyses. Mark-recapture models revealed that the population included both transient and territorial birds. Apparent survival of territorial birds was >0.98 but was reduced to <0.87 within the wind park. At least one collision mortality was confirmed as a local breeding bird. We synthesized our data into an age-structured population model and found that the local population of eagles at Smøla is self-sustaining despite the reductions in apparent survival.

Long-distance movements of edible bush-cricket Ruspolia differens revealed by hydrogen stable isotopes

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The African edible bush-cricket Ruspolia differens is the most consumed edible insect species in the Lake Victoria Basin, East Africa. Despite its high nutritional, cultural and economic importance in this region, the geographical areas producing the swarms have remained poorly understood. Based on the non-exchangeable hydrogen stable isotope compositions analysed in our study, at least 77% of non-swarming and 85% of swarming adults were of local origin. The non-local adults captured in Uganda likely originated from Ethiopia, Kenya or South Sudan. This suggest that R. differens swarms in East Africa are a panmictic population and long-distance movements are likely occurring with high frequency. However, because most individuals were of local origin, this emphasizes the need to conserve sufficient local grasslands in the harvesting regions to preserve the source populations as an important food source to the human population in East Africa.

Macro-nutritional balancing in northern Cervids

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Eating may seem deceptively simple. All organisms do it and the basic purposes such as the provision of energy and nutrients are well understood. Unraveling the drivers of specific food choices, however, has remained surprisingly challenging. It is becoming increasingly clear that the selection of food is not simply motivated by maximalization or limitation of any one nutrient, but rather involves balancing multiple nutrients simultaneously. This nutrient balancing hypothesis suggests that animals have evolved nutrient-specific appetites that guide their foraging decisions towards reaching a target balance of the key macronutrients protein, carbohydrates, and fat. Here, we will present recent evidence of macronutrient balancing in moose and other cervids. We will show how nutritional targets can drive foraging choices of nutritionally complementary foods such as pine and bilberry for moose and discuss possible implications for forestry and cervid management.

How does radionuclide bioaccumulation in fish vary depending on their size-dependent diet?

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Coastal food webs are prone to contamination from, e.g. radionuclides - unstable isotopes emitting ionising radiation. These are absorbed by lower trophic level organisms and transferred up food webs through feeding. Concentrations therefore

vary between species depending on their diet, but how this affects variation within species is unknown. We ask how radionuclide bioaccumulation in two fish species varies depending on their size-dependent diets. To this end, we combined analyses of stable isotopes and radionuclides for different sizes of perch (Perca fluviatilis) and roach (Rutilus rutilus), as well as organisms from lower trophic levels. We hypothesise that fish at lower trophic levels and feeding on benthic sources will accumulate higher concentrations of radionuclides than fish at higher trophic levels due to biodilution, especially in pelagic environments. We discuss how variation in radionuclide concentrations links to size-dependent diet, trophic level, and foraging habitat.

Session 15 -- BECC session: Biodiversity contributions to ecosystem function and services

14th March 2024 - Day 2 / 14:00 / Stora Salen, AF-Borgen

The impact of heterogeneity and tree diversity on predation pressure of insect herbivores in semi-natural boreal forests

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Tree species diversity has been expected to benefit top-down control of pest insects in forests. However, results concerning pest suppression by natural enemies are not unequivocal, and studies show differing results. Previous studies of the insect herbivore Neodiprion sertifer has shown that local heterogeneity is a better determinant of predation pressure than tree species diversity. We investigated the relationship between local heterogeneity, tree species diversity, and predation pressure of N. sertifer. We measured a wide range of heterogeneity factors in mixed forests and monoculture forests in semi-natural boreal forests in central Sweden. Our results showed that tree species diversity did not increase predation pressure at stand level. However, ant presence, ground vegetation characteristics, dead wood and boulders did affect predation pressure directly or indirectly within the stands. We conclude that local heterogeneity is more important than tree diversity at stand level.

Diversity benefits commercially significant conifers in Sweden: A single species perspective on mixed species forestry

Zsofia R. Stangl, Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå, Sweden/ Maja Sundqvist, Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå, Sweden/ Michael Gundale, Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå, Sweden

The standard management method of even-aged monocultures has come under considerable scrutiny in the Nordic region as society is demanding greater complexity in ecosystem services. But diversity is often seen as a trade-off by the industry, relative to managing forest for productivity. Few studies have yet addressed how Nordic tree species grow at the individual tree level, when grown in monocultures vs. mixtures. Using tree core data from the Swedish National Forest Inventory, we explored the effect of species mixtures on the 10-year basal area increment of pine, spruce and birch. In contrast to conventional knowledge, our analysis reveals that pine benefits from growing in more diverse stands across the country, while the response of spruce was temperature dependent. Overall, higher proportion of deciduous trees would benefit the growth of commercially significant conifers, and at the same time would substantially increase biodiversity in the conifer-dominated forests of Sweden.

Is it facts or perceptions that matter? A case study on the role of different types of environments for wellbeing

Ruslan Gunko, Åbo Akademi University/Novia University of Applied Sciences,/ Lauri Rapeli Åbo Akademi University/ Matias Scheinin, Pro Litore Association / Jenny Wikström, Pro Litore Association/ Nina Tynkkynen, Åbo Akademi University

The concept of well-being requires a complex approach covering different aspects of human life. The impact of the environment and its different attributes on people's well-being is one of the factors that require a detailed study.

In our research we investigated if different types of environments (coastal waters and forests) affect people's well-being in areas with accessibility to different environmental types, and if the role of the state of the environment for well-being is dependent on an objective state or on how people perceive it. Our results demonstrated the significant role of biodiversity in connection to the frequency of forest visits, and a similar significant effect of temporal changes in forests in connection to the frequency of forest visits. Similar effects on coastal water quality were absent. In contrast, we found that the perceptions for both water and environmental quality play a significant role.

More is not always better: peat moss mixtures slightly enhance peatland stability

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Wetland ecosystems challenge biodiversity–ecosystem function theory. Whether assemblages of co-occurring peat mosses contribute to the stability of peatland ecosystem processes is unknown. We conducted a two-species replacement series experiment to assess the stability of carbon (C) dynamics under mild and deep drought. Our results show a positive effect of mild drought on NEE with no clear role for peat moss mixture. Our study indicates that the C uptake capacity by peat moss mixtures is rather resilient to mild drought, but seriously affected by deeper drought conditions. Co-occurring peat moss species enhance the resilience of the C uptake function of peat moss mixtures only slightly, suggesting that Sphagnum mixtures only marginally contribute to peatland ecosystem function stability. Our results highlight that drought can gravely affect the C sink capacity of peatlands, with only a small extenuating role for peat moss mixtures.

The importance of beta-diversity for ecosystem stability in heterogeneous landscapes

Benedikt Schrofner-Brunner, Department of Marine Sciences, University of Gothenburg

Understanding the impact of changes in biodiversity on ecosystem functions is vital for both basic ecology and ecosystem management. However, the role of beta diversity in influencing spatial stability of ecosystem functioning at large scales in heterogeneous environments is underexplored. Our research, conducted in the Tjärnö archipelago, Sweden, addresses this gap by examining how the diversity of marine fouling organisms is related to biomass production in seascapes of varying spatial environmental heterogeneity. We found that beta diversity stabilises biomass production in heterogeneous environments but not in homogeneous environments. Our work, aligning with previous grassland-based studies, underscores biodiversity's key role for ecosystem function stability at larger scales.

Understanding the Interplay: Nature-based Solutions, Biodiversity Conservation, and Climate Mitigation

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Nature-based solutions (NbS) are recognized as a promising strategy to tackle biodiversity loss and climate change. NbS involves sustainable management of

natural and semi-natural ecosystems to achieve multiple benefits for nature and society. However, the link between biodiversity and climate mitigation through carbon sequestration in NbS is often overlooked. The work presented here explores literature on NbS, identifies gaps in understanding the functional biodiversity's role in such solutions, and introduces a conceptual framework to clarify links between biodiversity components of NbS. We review their mechanistic implications for carbon sequestration, resilience for carbon storage, and conservation values. We synthesize information from ecological theory and validate the framework using examples from mixed species forests and agroforestry. The framework provides a guide for policies to address climate mitigation and biodiversity conservation objectives through sustainable land use.

Valuing unexplored biodiversity and its relationship with nutrient cycling across changing upland environments

Jake Freddie Spong, Department of Environment and Geography, University of York, UK/Rob Mills, Department of Environment and Geography, University of York, UK/Aidan Keith, UK Centre for Ecology & Hydrology, Lancaster, UK/Ashley Lyons,Department of Biology, Edge Hill University, UK

Soil mesofauna are present at multiple trophic levels in the soil food web and are amongst the most abundant animals on the planet. However, the value of such organisms (e.g. mites, collembola, nematodes) to carbon dynamics and nutrient cycling remains underappreciated and overlooked in policy and land management. With increasing rates of pastoral land abandonment in Europe and an increasing interest in ecological restoration, understanding how changing upland environments affect soil biodiversity and functioning from the mesofauna perspective is essential. We therefore explored the relationship between soil mesofauna diversity and physicochemistry across a proxy chronosequence of ecological restoration in the Lake District, UK. Initial results indicate that management and vegetation affect soil carbon and nutrient status, with bracken notably having different effects on carbon under different grazing regimes. Mesofauna diversity remains to be quantified.

Session 16 -- Thermal ecology

14th March 2024 - Day 2 / 14:00 / Palaestra A

Causes and consequences of simultaneous shifts in consumer size and species composition caused by climate warming

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Variation in thermal responses across trophic levels can lead to major warming-induced shifts in biomass distributions. Despite inherent constraints imposed by both taxonomic composition and body size, studies on how warming changes biomass distributions generally ignore the role of simultaneous shifts in species and size composition. Here, we compare (1) effects of whole-ecosystem warming on interspecific versus intraspecific size structure of zooplankton consumers and contrast these to theoretical predictions, and (2) how thermal origin and resulting variation in size and species composition of zooplankton communities can modify bottom-up and top-down effects of warming. We discuss results suggesting that intraspecific size shifts is key for how whole community size distributions respond to warming and show how thermal origin of consumer communities can modulate the extent to which warming leads to more or less bottom-heavy biomass pyramids.

Responses of metabolic rate and foraging behavior to temperature

Milad Shokri, Laboratory of Ecology, DiSTeBA, University of Salento, Italy / Alberto Basset A LifeWatch ERIC, Italy

Considering the urgent concern over ongoing climate change and the importance of the relationship between metabolic rate and behavioral patterns in aspects of energy-based ecological theory, we aimed to investigate how the foragers' metabolic rate (SMR) influences modes of behavior. Using the amphipod Gammarus insensibilis as the model organism, we examined how variations in SMR affect behavioral patterns, specifically space use, patch selection, and giving-up time, across specimen body masses and environmental temperatures. We observed that with warming, the specimens explored greater space/resources to offset the elevated SMR due to the depletion of somatic energy resources. Our results further showed that metabolic phenotype (mass and temperature-independent) strongly influences foraging decisions regarding patch choice and partitioning; specimens with a higher metabolic phenotype showed a marked preference for the most profitable resources and gave up earlier than others.

Physiological consequences of growing up at extreme temperatures

Elin Persson, Lund University, Department of Biology / Maria Correia, Lund University, Department of Biology / Ciarán Ó Cuív, Lund University, Department of Biology / Andreas Nord, Lund University, Department of Biology

In birds, changes such as increased temperature instability due to climate change during the developmental period can directly affect growth, metabolism, and temperature tolerance of the offspring. However, we have poor understanding of whether these changes remain in adulthood. We therefore investigated if any phenotypic consequences of the thermal environment in early life manifested as legacy effects in adulthood. This was achieved by raising Japanese quail under simulated heatwave- and cold snap conditions, and in a common garden afterwards. We then measured how the birds dealt physiologically with variation in environmental temperature halfway through development and again in adulthood. In this talk, we detail the short and long-term effects of heatwaves and cold snaps on the physiological machinery responsible for keeping the birds warm or cool.

Exploring Thermal Physiology and Aerobic Scope in Salmon Juveniles Amidst Heatwaves

Lucy Cotgrove, LUKE/ Evan Sala, Luke/ Jenni Prokkola, LUKE

Aquatic ectotherms become more vulnerable during heatwaves due to increased energy needs and reduced oxygen in warmer waters. Understanding thermal physiology is critical for population shifts. Heatwave risk assessments often focus on immediate effects, disregarding long-term physiological constraints and fitness impacts. The age at which organisms mature is genetically linked to their ability to use oxygen, a key factor in energy distribution, and responds strongly to environmental temperatures. By measuring how salmon juveniles manage energy at temperatures ranging 16 - 23°C, we bridge the gap between physiological heatwave effects, life history and fitness of salmon. Relating thermal performance to genetic differences in maturation timing, we show how energy distribution changes between life strategies at different temperatures. These findings provide better understanding how evolution responds to climate change and in developing conservation strategies for Atlantic Salmon.

How does environmental temperature during growth affect metabolism of birds in adulthood?

Elisa Thoral, Lund University, Department of Biology, Section for Evolutionary Ecology / Maria Correia, Lund University, Department of Biology, Section for Evolutionary Ecology / Matilda Langreiter, Lund University, Department of Biology, Section for Evolutionary Ecology / Malin Schött, Lund University, Department of Biology, Section for Evolutionary Ecology / Lukas C. Breschel, Lund University, Department of Biology, Section for Evolutionary Ecology / Elin Persson, Lund University, Department of Biology, Section for Evolutionary Ecology / Imen Chamkha, Lund University, Department of Clinical Sciences, Mitochondrial Medicine / Eskil Elmér, Lund University, Department of Clinical Sciences, Mitochondrial Medicine / Joshua Tabh, Lund University, Department of Biology, Section for Evolutionary Ecology / Andreas Nord, Lund University, Department of Biology, Section for Evolutionary Ecology

An increase in the frequency and intensity of extreme temperature events can affect energy production in birds. We reared Japanese quail Coturnix japonica in cold snap (10°C) or heatwave (30°C) conditions until adulthood, and then moved half of them to a common garden (20°C) to study how mitochondria are affected by temperature, and if this changes over the animals' life. In a separate study, birds were reared at 20°C and then acclimated to 10 or 30°C as adults. At various key points in their lives, blood samples were taken to study mitochondrial metabolism. Individuals raised at 30°C had a lower mitochondrial metabolism compared to those raised at 10°C. However, this pattern was reversed once the birds were moved to 20°C. In thermally acclimated adults, mitochondrial metabolism increased in the cold, but did not change in the warmth after 3 months. These studies enabled us to track the intraindividual variation of mitochondrial metabolism in relation to the temperature exposure.

Constitutive responses in body growth of pike to increased water temperature

Örjan Östman, Swedish University of Agricultural Sciences, Department of Aquatic Resources, Box 7018, 750 07, Uppsala, Sweden

For large bodied and predatory fish previous studies suggest that somatic growth first increase with temperature until the optimal condition is reached after which metabolism succeed energy intake and oxygen deficiency reduce growth. However, in nature can global change affect many other processes than metabolism impacting somatic growth rate. One driver may be evolutionary adaptations to temperatures changes, rarely investigated. Here I show that somatic growth of northern pike in a Baltic Sea archipelago indeed has increased with water temperature over the last 60 years indeed. However, the change is almost completely reliant on constitutive increase in somatic growth of individual pike over time with little individual response or plasticity to changes in water temperatures. These constitutive differences may depend on evolutionary changes but could also be due to food-web or behavioral changes.

Shrinking, but not shape shifting, is explained by thermoregulatory costs at extremes in birds

Joshua Tabh, Lund University / Elin Persson, Lund University / Elisa Thoral, Lund University / Andreas Nord, Lund University

Amassing evidence now shows that birds across the globe are shrinking and becoming longer-limbed as our planet warms. Although the cause of these changes is unclear, many have offered selection for improved thermoregulatory efficiency as an explanation (i.e. by increasing surface area to volume ratios and easing heat dissipation). Using established allometries, however, we show that thermoregulatory benefits accrued through mean changes in morphology are minimal. Next, using the Japanese quail, we show that large body sizes only increase thermoregulatory costs in the heat when extreme; appendage length held no influence on thermoregulatory costs across a wide temperature range. Last, we show that high developmental temperature in quail, and many endotherms, increases relative limb length but minimally alters mass. We conclude that rising temperature may be: (1) driving species masses down by taxing large “outlier” individuals, and (2) shifting limb lengths via non-adaptive plasticity.

Session 17 -- Urban ecology

14th March 2024 - Day 2 / 14:00 / Palaestra B

Key pollinator groups show contrasting trait-mediated responses to urbanisation and agricultural intensification

Anna Sofie Persson / Henrik G. Smith / Johan Ekroos

While both urbanisation and agricultural intensification are recognised as drivers of pollinator declines, urban green areas are potential safe havens for pollinators. We investigated if the processes of urbanisation (green space loss, increased human density) and agricultural intensification (semi-natural habitat loss, incresed field size, crop yield) have similar effects on different pollinator taxa. We sampled bees and hoverflies in urban and rural sites and assessed trait-environment associations using RLQ and 4th corner methods. For urban bee communities, vegetation cover and human density interacted with several traits, but local habitat was the most important driver. In rural environments only nesting habitat was affected. In contrast, for urban hoverflies only phenology was affected by, while rural communities clearly differed across environmental gradients and local habitat. We conclude that largely different traits-groups suffer from urban and agricultural intensification.

Reconciling Ecosystem Functioning and Public Aesthetic Preferences: Insights from a North-Norwegian Flowerbed Experiment

Eva Breitschopf; UiT – The Arctic University of Norway - Department of Arctic and Marine Biology, BFE /Aaron Feicht; VERTE landskap-arkitektur AS/ Eimear Tynan; UiT – The Arctic University of Norway - Academy of Arts, UMAK/ Anita Veiseth; VERTE landskap-arkitektur AS/Thomas Clemmensen; UiT – The Arctic University of Norway - Academy of Arts, UMAK/ Kari Anne Bråthen; UiT – The Arctic University of Norway - Department of Arctic and Marine Biology, BFE

Urban areas need patches of functioning ecosystems to counteract biodiversity loss. These patches need acceptance by the public. However, apparent messiness due to the aesthetics of native plant species and high species richness needed for good ecosystem functioning may oppose the expected appearance of order in urban settings. This could lead to a low acceptance of flowerbeds designed in such a way. We studied people's views on 12 flowerbeds designed for good ecosystem functioning in four levels of native species richness (8,12,16,20) and three levels of order (no, semi, full).

We found a positive mean rating for all flowerbeds. We found no effect of species richness on the rating, while increased order had a negative effect: 4% and 12% lower ratings for semi and full order.

These findings challenge the assumption that aesthetics aligned with good ecosystem functioning are not accepted by people. Specifically, we show that order in such flowerbeds decreases people's liking for them.

Plant adaptations to city life: lessons learnt from dandelions

Yannick Woudstra, Stockholm University & Netherlands Institute of Ecology / Barbara Gravendeel, Naturalis Biodiversity Center & Radboud University Nijmegen / Tanja Slotte, Stockholm University / Koen J.F. Verhoeven, Netherlands Institute of Ecology

In present-day urban environments, the predicted effects of climate change are already normalised, making cities ideal experimental gardens for studying the necessary biological adaptations. To discover the necessities for surviving urbanisation, we looked at a thriving urban plant species: the common dandelion (Taraxacum officinale F.H.Wigg. s.l.). Along urban-rural transects, urban plants were superior in seedling growth at higher temperatures and flowering response at shorter vernalisation exposure. Flowering time was advanced for suburban plants, both in the field and in controlled environments. These patterns are reflected in highly conserved urban genotypes for genes regulating flowering phenology and heat resistance. Effects were significantly different between urban habitats, where city park plants presented phenotypes intermediate of urban street and rural field populations. Rapid urban adaptation is therefore likely the result of localised environmental filtering.

Urbanisation drives intraspecific variation in flight-related traits of aquatic insects at different landscape scales

Wenfei Liao / University of Helsinki, Finland Hao/Lin/University of Electronic Science and Technology of China

Urbanisation, as an unstoppable global phenomenon, has given strong pressure on organisms due to the decreasing number of and connectivity between habitats. Few studies have investigated urban effects on aquatic insect species traits at the species level. Here, we present our results of how flight-related morphological traits of three Dytiscidae species change along an urban gradient at nine different landscape scales from 100m to 1200m in the Helsinki Metropolitan Area, Finland. We found that urbanisation affects the morphological traits, but not all species, not all traits, not all scales. The results indicate some species may be pre-adapted to urbanisation, while some species apply different strategies to cope with movement barriers in urban landscapes; although species may adjust morphological plasticity for better dispersal, such ability is limited. Urban planning should consider landscape scales at which species can endure urbanisation in aquatic biodiversity conservation.

Long-term changes in Nordic green roof ecosystems: Implications for ecosystem services

Ishi Buffam, Swedish University of Agricultural Sciences (SLU) / Susanna Lehvävirta, University of Helsinki / Tobias Emilsson, SLU / Åsa Ode Sang, SLU / Petra Thorpert, SLU / Ayako Nagase, Chiba University / Ronja Zellmer, SLU / Maria Kunle, University of Hohenheim / Amy Heim, University of Montreal / Mark E. Mitchell, University of Cincinnati / Long Xie, University of Helsinki / Xi Shu, University of Helsinki

Current understanding of green (vegetated) roof ecosystems comes mainly from short-term studies, giving little insight into likely changes over the expected 50+ year life span. To address this gap, we examined long-term variation in plant communities and substrate characteristics as indicators of a suite of ecosystem services (ES) for green roofs in Malmö, Sweden, and Helsinki, Finland. We found no change in vascular plant species richness over time, but species assemblages shifted, accompanied by increases in moss and lichen cover. This change was accompanied by an increase in substrate water-holding capacity, as well as carbon and nitrogen storage; all of which could indicate enhanced provision of regulating ES. An analysis of public perception of aesthetics and stress-reducing capacity of the roofs showed that the color of the plant community played a large role. Overall, the changes observed suggest intriguing potential synergies and tradeoffs among different ES as green roofs age.

Oxidative damage in urban bumblebees

Johan Kjellberg Jensen, Centre for Environmental and Climate Science, Lund University / Josefin Hersén, Department of Biology, Lund University / Susana Garcia Domínguez, Department of Biology, Lund University / Alessia Ostolani, Department of Biology and Environmental Science, Linnaeus University / Anna S. Persson, Centre for Environmental and Climate Science, Lund University / Caroline Isaksson, Department of Biology, Lund University

Cities are stressful environments in several senses of the word for wild animals, including being linked to an increased risk for oxidative stress – the imbalance between pro- and antioxidants. Several factors such as air pollutants can cause this detrimental state, but studies documenting urbanization's effect on arthropod physiology are scarce. Here, we measured the oxidative damage and antioxidant capacity of wild bumblebees (Bombus terrestris and B. lapidarius), in and outside of a city. We found increased oxidative damage across both species in urban sites but no discernible response in terms of antioxidants. Our results show that urban environments can directly and detrimentally impact arthropod physiology. Moreover, the lack of antioxidant response on the individual level opens the question of the colony-wide outcome of urban oxidative stress in bumblebees.

Urbanization alters fungal functional diversity: Larger-spored and pathogenic taxa thrive in cities

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Urbanization poses a significant threat to biodiversity, yet the impact on microbial diversity, especially microscopic fungi, has been overlooked. To address this gap, we studied the effects of urbanization on the functional traits of fungi along five gradients in Finland. Focusing on traits crucial for plant and animal responses to urbanization, such as dispersal and resource use, we measured turnover in resource-guilds and spore size. Despite a mild impact on fungal guild turnover, pathogenic guilds affecting lichens and animals (including humans), increased in urban environments. Large-spored taxa dominated all functional groups in urban settings, indicating the influence of abiotic stress on fungal communities in cities. Our findings highlight the altered fungal functional diversity in urban areas, with potential implications for ecosystem functioning. Notably, urban environments support the thriving of animal pathogens, raising concerns about health risks for inhabitants.

Session 18 -- Mechanistic models for a complex world: advances and insights

14th March 2024 - Day 2 / 14:00 / Kerstinsalen, AF-Borgen

Complex life cycles and ecological contexts drive community assembly through evolutionary diversification

Marco Saltini, Wageningen University, Uppsala University, Swedish Collegium for Advanced Study / Paula Vasconcelos, Uppsala University / Claus Rueffler, Uppsala University

Most eukaryotic organisms have complex life cycles, with ecological interactions shifting between juvenile and adult stages. Our models explore the impact of complex life cycles on community assembly through trait-dependent evolutionary diversification under diverse ecological contexts: different resource availability and different genetic architectures. We show that community richness depends on ecological contexts: gradual evolution results in variable species richness depending on resource availability, while mutations of large phenotypic effect promote the assembly of communities of species with complex life cycles. This reveals that complex life cycles do not inherently broaden the scope for evolutionary diversification, as the latter strongly depend on ecological contexts. This underscores the need for consideration of ecological contexts in trait-dependent diversification studies and, more specifically, in eco-evolutionary models of diversification.

Combine modeling and experiments to study cyclic dominance games between Escherichia coli strains

Thierry Kuhn , University of Neuchâtel / Pilar Junier, University of Neuchâtel / Redouan Bshary, University of Neuchâtel / Céline Terrettaz, University of Neuchâtel / Diego Gonzalez , University of Neuchâtel/ Xiang-Yi Li Richter, University of Neuchâtel and University of Bern

Evolutionary game theory has provided various models to explain the coexistence of competing strategies, one of which is the rock–paper–scissors (RPS) game. A system of three Escherichia coli strains—a toxin-producer, a resistant and a sensitive—has become a classic experimental model for studying RPS games. Previous experimental and theoretical studies, however, often ignored the influence of ecological factors such as nutrients and toxin dynamics on the evolutionary game dynamics. In this work, we combine experiments and modelling to study how these factors affect competition dynamics. Using three-dimensional printed mini-bioreactors, we tracked the frequency of the three strains in different culturing media and under different flow regimes. In our simulations, we explicitly modelled

the release, removal and diffusion of toxin. We showed that the amount of toxin that is retained in the system is a simple indicator that can predict competition outcomes across broad parameter space.

Central place foragers, resource depletion halo's and how the ideal free distribution promotes consumer coexistence

Claus Rüffler, Department of Ecology and Genetics, Uppsala University / Laurent Lehmann, Department of Ecology and Evolution, University of Lausanne, Switzerland

Many seabirds are central place foragers during breeding when they congregate in large colonies. It has been suggested that competition between birds results in an area of reduced prey availability around colonies, a phenomenon known as Ashmole's halo, and that this limits colony size. We develop a model for central place foragers exploiting prey in a two-dimensional environment. The prey distribution results from intrinsic birth and death, movement and mortality due to foraging birds. This mortality results from birds foraging at different distances according to an ideal free distribution that maximizes prey delivery in the presence of flight and search costs. We show that prey depletion halos are a robust outcome and that coexistence of different seabird species within a colony is possible through behavioral segregation whenever differences between species entail trade-offs between exploiting a scarce prey close to the colony and a more abundant prey far away.

Comparing ecosystems with and without mycorrhizae

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Symbiotic associations between mycorrhizal fungi and plants are fundamental for both plant nutrition and carbon (C) storage in soil. Plants invest photosynthetically aquired C in symbiotic relations in exchange for nutrients that mycorrhizae mine from organic matter, and this plant-derived C can eventually be stabilized in the soil.

Capturing these interactions between the symbiotic partners in process-based models is vital for both quantifying the C and nutrient cycles and understanding how mycorrhizae support ecosystem functions. By including mycorrhizae in ecosystem models one can study the importance and effects of mycorrhizae in ecosystems. Here we use an ecosystem model to compare systems with and without mycorrhizae. We found a higher plant biomass and respiration rates when including mycorrhizae. However, due to the decomposition ability of mycorrhizae plant productivity increased at the cost of C loss in the soil when including mycorrhizae.

Can we leverage niche complementarity to adapt crop production to climate change? A modelling analysis of intercropping

Giulia Vico, Department of Ecology, Swedish University of Agricultural Sciences (SLU)/Martin Weih, Department of Crop Production Ecology, Swedish University of Agricultural Sciences (SLU)/Herman NC Berghuijs, Plant Production Systems, Wageningen University & Research

Diversification in agriculture can support crop yields, while reducing the negative effects of agriculture on the environment. One diversification option is intercropping, i.e., simultaneously growing two or more species occupying different ecological niches in the same field. Because of the many and complex intra- and inter-specific interactions, and their response to the environment, it is not trivial to determine which plant teams provide the largest benefit under current and future climatic conditions. We use the Minimalist Mixture Model, M3, to evaluate the yields of legume-cereal intercrops and pure cultures, and their temporal stability, across pedoclimatic conditions. On a per unit area basis, historical vs. future climatic conditions do not alter the general pattern of yield of pure cultures vs intercrops. Nevertheless, against expectations, intercropping increased yield variability and sensitivity to changes in climatic conditions, when considering current crop varieties.

Assessing theoretical economic models using artificial landcover generators and spatially explicit ecological models

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Ecological economics is a rising field in the study of sustainable living, focusing on valuation of ecosystem services, and tradeoffs between ecosystem and human needs. A major focus of this field is applying economics tools to landcover decision making by using different methods, such as portfolio theory, and multi-criteria decision making. One drawback of these methods is that results are not spatially explicit, while many ecosystem services depend on spatial configuration. To overcome this, we have developed a landcover generator that mechanistically produces agricultural landscapes based on parameters such as soil, topography, and field geometry. These landscapes can give spatially explicit representation to the non-spatial economic models. These landscapes can then be coupled with animal movement models that can simulate spatial processes. The entire pipeline, from theoretical models to spatially explicit movement models, helps us assess ecological impact of economic models.

Optimal control models for microbial resource acquisition strategies

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Organic matter decomposition is regulated by microorganisms. We assume that such regulation allows them to maximize their growth and translate this assumption in optimal control models that address three tradeoffs: i) consuming resources fast allows growth for a short period, whereas slow consumption allows prolonged but slow growth, ii) fast resource acquisition requires disproportionally large costs, whereas slow acquisition leaves resources to competitors, and iii) some resources are unavailable unless additional investments are made first. We show that optimal decomposition kinetics balance inefficient but fast acquisition of plentiful resources and efficient but slow acquisition under resource scarcity. Also, optimal timing of lignin degradation and investment in enzymes for carbohydrates hydrolysis during decomposition depend on both climate and litter chemistry. These examples demonstrate the potential for optimal control models to capture microbial processes in simple models.

Session 19 -- DDLS: the importance of data driven science in ecology and evolution

15th March 2024 - Day 3 / 10:30 / Palaestra A

Spatial biodiversity modeling with remote sensing and AI

Tobias Andermann

Convolutional Neural Networks (CNNs) allow the seamless integration of multiple complex and heterogenous data types, making them very suitable tools for modeling biodiversity. Here we apply such CNN models to learn the complex correlations between biodiversity and the multidimensional biotic and abiotic matrix that the species community interacts with and exists within. The proof-of-concept model is trained on polygons with high and low biodiversity values distributed across Sweden. The model learns how to correlate biodiversity value with the multitude of spatial predictors used in the model, including data products

from remote sensing techniques. This allows us to produce continuous heat-maps (rasters) of biodiversity value across the entire country of Sweden at a 10x10m spatial resolution, providing estimates at a spatial scale that is useful for conservation planning, biodiversity offset evaluation, and simulation-based (in silico) impact assessments of infrastructure projects and other anthropogenic landscape modifications. In our ongoing work we are combining this model architecture with high-resolution biodiversity data generated with environmental DNA, improving the predictive power and taxonomic resolution of these models. With increasing biodiversity data becoming available across the world, these models can eventually be applied on a global scale, constituting computational tools for standardized and automated high-resolution biodiversity predictions and impact assessments.

Integrating UAV, deep learning, sound, and field data to assess the impact of ant mounds on the treeline ecotone

Jérémy Monsimet, Department of Ecology and Environmental Science, Umeå University / Matthias Siewert, Department of Ecology and Environmental Science, Umeå University

Mound-building ants are ecosystem engineers, but their impact on the treeline ecotone has been understudied. We used a deep-learning model and UAV data, including RGB and multispectral, to detect ant mounds and assess their impact on vegetation. We found that the NDVI was higher within 2m of ant mounds, indicating greener and more abundant vegetation. Field data confirm the positive impact on plant density, shrub biomass, and leaf nitrogen content in the vicinity of the mounds. Therefore, our work demonstrates that ants are an important component of the treeline ecotone with a substantial impact on vegetation productivity. By exploring foraging activities, we also quantified seasonal flux patterns and investigated new sound recording techniques to measure this seasonal variation. Our study establishes ants as overlooked drivers of tundra shrubification, providing insights into their spatial impact, crucial under ongoing climate change.

An insect species multimeter for troubleshooting landscape ecology

Mikkel Brydegaard 1,2,3 / Meng Li 1 / Klas Rydhmer 4 / Benoit Kouakou 5 / Adolpe Gbogbo 5 / Jeremie Zoueu 5 / Carsten Kirkeby 4 / Anna Runemark 2 / Henrik Smith 2 / 1 Dept. Physics, Lund University, Sölvegatan 14c, 22363 Lund, Sweden / 2 Dept. Biology, Lund University, Sölvegatan 35, 22362 Lund, Sweden / 3 Norsk Elektro Optikk, Østensjøveien 34, 0667 Oslo, Norway / 4 Copenhagen University, Copenhagen, Denmark / 5 Institut National Polytechnique Félix Houphouët-Boigny, Yammousoukro, Ivory Coast

Monitoring insect diversity and its decline can be a costly and time-consuming business, both in terms of trapping campaigns and post-capture identification. Automated approaches by distributed sensors could imply better coverage and

resolution in time and space, instant classification and potentially speed up the evaluation of insect decline mitigations. We present progress and current state of automated alternatives based on lasers and photonics. We can currently remotely count hundreds of thousands of insects daily in the field, and retrieve their oscillatory properties individually and differentiate hundreds of taxonomic groups. How and why does it work? How well does it work? What are the advantages, challenges and limitations? What molecular, nano- and micro-structural features can be measured on free flying insects in nature, and to what extent can these observational features be used to distinguish species richness and taxonomic group?

aMeta: a computational method for data-driven ancient metagenomic analysis

Nikolay Oskolkov

Biology Department, Science for Life Laboratory, National Bioinformatics Infrastructure Sweden, Lund University, Lund, Sweden

Analysis of microbial data from archaeological samples is a growing field with great potential for understanding ancient environments, lifestyles, and diseases. However, high error rates have been a challenge in ancient metagenomics, and the availability of computational frameworks that meet the demands of the field is limited. Here, we propose aMeta [1], an accurate metagenomic workflow for ancient DNA designed to minimize the amount of false discoveries and computer memory requirements. Using simulated data, we benchmark aMeta against a current state-of-the-art workflow and demonstrate its superiority in microbial detection and authentication, as well as substantially lower usage of computer memory.

[1] Z. Pochon, N. Bergfeldt, E. Kırdök, M. Vicente, T. Naidoo, T. van der Valk, N. E. Altınışık, M. Krzewińska, L. Dalen, A. Götherström, C. Mirabello, P. Unneberg, N. Oskolkov, aMeta: an accurate and memory-efficient ancient Metagenomic profiling workflow, Genome Biology 2023, 24 (242)

High-throughput experimental community ecology: combining robotics with machine learning

Paulina A. Arancibia, University of Jyväskylä / Otso Ovaskainen, University of Jyväskylä

Drivers behind community ecology are complex and thus difficult to fully understand. Though observational data on patterns is ample, experimental data lags since the cost of experiments restricts their scale of inquiry and/or level of replication.

Technological advances allow using robotics to run high-throughput experiments (HTE) with low manual effort, as well as automating pipelines to process data without major human effort. Despite this promise we show that automated HTE are rare in community ecology, even if some automated methods are part of a study. We discuss the potential, bottlenecks and limitations of using automated HTE in community ecology, and as proof of concept, we present a case study with protists where we show the feasibility of running HTE coupling robotic microscopy and machine-learning. Albeit HTE are rarely used in community ecology, they present great potential, still their use requires effort and the methods cannot be directly generalized among study systems.

The use of novel acoustic technologies to study and monitor bird communities in biodiverse areas

Christos Mammides / Nature Conservation Unit, Frederick Universit / Christina Ieorymidou / BirdLife Cyprus / Harris Papadopoulos / Department of Electrical Engineering, Computer Engineering and Informatics, Frederick University

The Kunming-Montreal Global Biodiversity Framework aims to reverse biodiversity loss and promote living in harmony with nature by 2050. To achieve this goal, it is necessary to develop tools that can be used to study and monitor anthropogenic impact on biodiversity over large spatial and temporal scales. Recent technological advancements have introduced novel tools, such as passive acoustic technologies, which have been shown promising for studying soniferous animals. Here, we present the results of using acoustic technology to monitor bird species richness in sixty biodiverse sites in Cyprus, which are surveyed annually as part of the pan-European Common Bird Monitoring Scheme. Using machine algorithms and acoustic data from a subset of these sites, we are able to accurately predict the bird richness of sites not seen by the trained model. Our approach holds promise for scaling up monitoring schemes and gaining a better understanding of how human activities affect bird communities.

Session 20 -- Computer vision

15th March 2024 - Day 3 / 10:30 / Kerstinsalen, AF-Borgen

Sensors and AI in seabird research and monitoring

Jonas Hentati-Sundberg, Swedish University of Agricultural Sciences

New sensor technologies and Artificial intelligence can speed up learning about species and populations and increase the utility of ecological field studies to inform environmental management. We have developed automated methods for monitoring of seabirds, which are often monitored for their high conservation value and for being sentinels for marine ecosystem changes. Using video surveillance combined with automated image processing, we continuously monitor breeding seabirds in a semi-natural environment – an artificial cliff in the middle of a large seabird colony on Stora Karlsö, Sweden. We demonstrate how computer vision-based object detection can be used to accurately monitor phenology and chick growth and generate surprising insights on disturbances from predators and impacts of heat waves. Ongoing development includes automated identification and quantification of behaviors, prey deliveries, automated weighing of birds and tracking and identification of individuals.

Globally standardised species monitoring with insect camera traps and deep learning models

Toke Thomas Høye, Aarhus University, Denmark

With computer vision and deep learning, insect camera traps have become key tools to improve knowledge on insect responses to environmental change. Through computer eyes, it is potentially possible to effectively, continuously, and non-invasively observe insects throughout diurnal and seasonal cycles and deep learning models can provide estimates of their abundance, biomass, and diversity. I will unpack and visualize the rich and multidimensional data that novel camera-enabled monitoring systems are capable of generating automatically and in a globally standardized manner. Through results from national and continental scale pilot programs deploying insect camera traps, I will provide a glimpse into the insights that can be derived from the trap images and what the future of automated insect monitoring might look like. I will also highlight challenges and future research avenues to facilitate the broad scale implementation of insect camera traps for day active and nocturnal insects.

Using computer vision for a quick estimation of ungulate reproduction from camera trap images

Magali Frauendorf, Swedish University of Agricultural Sciences, Department of Wildlife, Fish, and Environmental Studies, Umeå / Filip Ånöstam, The Swedish Association for Hunting and Wildlife Management / Joris Cromsigt, Swedish University of Agricultural Sciences, Department of Wildlife, Fish, and Environmental Studies, Umeå / Fredrik Widemo, Swedish University of Agricultural Sciences, Department of Wildlife, Fish, and Environmental Studies, Umeå / Tim Hofmeester, Swedish University of Agricultural Sciences, Department of Wildlife, Fish, and Environmental Studies, Umeå /

Camera traps are a useful tool in wildlife research and management, also providing information on life history traits (e.g. calf recruitment). However, methods of processing the vast image data are very time-consuming. The automatic identification of species on camera trap images has already been applied globally, but identifications of other features (e.g. sex) to extract demographic parameters are rare. Especially with changing climate, there is need for quick management adaptation. For example, moose monitoring in Sweden takes place during autumn hunt of the previous year meaning that the reproductive season is not considered. This becomes relevant in years with extreme environmental events as reproduction may be negatively affected. To overcome this challenge we provide a deep learning model that classifies automatically sex and age of ungulates with high accuracy leading to quicker image processing, shorter feedback loop between monitoring and management and improved management.

Analyzing the Phytoplankton Community Structure with Computer Vision

Martin Marzidovšek, Jožef Stefan Institute / Patricija Mozetič, Marine Biology Station, National Institute of Biology / Janja France, Marine Biology Station, National Institute of Biology / Vid Podpečan, Jožef Stefan Institute

Phytoplankton are key for oceanic organic matter production and carbon cycling. Their diversity affects marine ecosystems' structure and processes, with cell size and shape critical for nutrient uptake and stability within the euphotic zone. Climate change, manifesting as increased seawater temperature and changing river patterns, is leading to smaller phytoplankton cells. Our research investigates how these climatic shifts affect phytoplankton physiology and community structure, thereby altering marine ecosystems and its functions. We employ computer vision to identify and quantify phytoplankton species, estimate cell size, and calculate biovolume based on cell morphology. This approach involves fine-tuning a generic pretrained model for instance segmentation with microscope images from the Adriatic Sea. Compared to manual analysis, this method processes more samples, providing a more ecologically relevant assessment of the impacts of climate change on marine phytoplankton.

Using Citizen Science Data for Training Taxonomically Informed Deep Classifiers

Asger Svenning, Department of Ecoscience, Aarhus University

The global biodiversity crisis has prompted renewed calls for broader, better and cheaper monitoring of ecological communities, while the recent advances in deep learning has provided a new frontier for complex machine learning, particularly within computer vision, which has traditionally been unable to be close to on par with human experts in detecting and classifying biological species visually. Although deep learning models have proved a significant potential, they are notoriously data hungry, needing thousands - if not more - of images in order to train good models. Building on recent work with taxonomically informed training of species classifiers for insect classification, I show how a principled approach to training insect classifiers on millions of aggregated citizen science images from GBIF, show the benefits of automatic learned quality filtering, balanced training to avoid downsampling and a way to strictly enforce correct multi-taxonomic-level predictions and training.

Expansion of mountain birch woodlands from aerial photo observations (1954-2022): Rates, patterns, and potential drivers

Anna M. Behrend, Agricultural University of Iceland, Keldnaholt, Árleynir, 112 Reykjavík, Iceland / Emmanuel P. Pagneux, Agricultural University of Iceland, Keldnaholt, Árleynir, 112 Reykjavík, Iceland / Arne Pommerening, Swedish University of Agricultural Sciences, Skogmarksgränd 17, 901 83 Umeå, Sweden / Ása L. Aradóttir, Agricultural University of Iceland, Keldnaholt, Árleynir, 112 Reykjavík, Iceland / Kristín Svarvarsdóttir, Land and Forest Iceland, Keldnaholt, Árleynir, 112 Reykjavík, Iceland / Þóra E. Þorhallsdóttir, University of Iceland, Sæmundargötu 2, 102 Reykjavík, Iceland

Restoration of native woodlands is of high global importance, but investigating the drivers of their contemporary spatial extents remains a challenge both in science and in practice. The objective of our study was to ascertain rates and spatiotemporal patterns of native birch woodland expansion and relate them to environmental drivers. We used image segmentation and unsupervised mixed with object-based classification analysis of aerial photos to monitor woodland expansion over nearly 70 years on nine areas with native birch woodlands in Iceland. Our methodology had an overall high accuracy (mean kappa coef. of agreement: 0.87). The results revealed that the woodlands have been expanding with an average rate of 2 ha/year driven mainly by temperature increases and changes in land use. The results from our study provide new insights on how historical information such as aerial photos can be utilized for valuable ecological information that can guide future decision-making in restoration.

Posters

Poster session 1

13th March 2024 - Day 1 / 17:30 (posters available all day) / AF-Borgen

1

Difficulties and Dilemmas in Defining Nativeness of Vascular Plants

Camilla T. Colding-Jørgensen, University of Copenhagen / Associate Professor, Hans Henrik Bruun, University of Copenhagen / Professor, Rasmus Ejrnæs, Aarhus University

Native and non-native plant species have different status in nature conservation. Non-native species are usually not prioritized for conservation actions, as they are thought of as not 'natural' to the area in focus, and because some of them have negative effects on native species. Several challenges arise from this, such as what defines 'natural' and 'negative effect'. Moreover, it is difficult to define 'nativeness' for several reasons: 1) the biologically arbitrary nature of political borders, and limited knowledge of: 2) species' natural range over time, 3) migration potential, 4) historical species interactions, and 5) time/mode of arrival in a country. We propose a multi-step definition of nativeness, rather than a binary, and apply this new framework to Danish vascular plant species based on published sources of pollen/macrofossil evidence and historical distributions. We find applying a nuanced concept of nativeness changes the status of most non-native plants to near-native.

2

Owning biodiversity: Linking biodiversity indicators and forest ownership

Kim André Anstensen Nielsen/Norwegian University of Life Science

In my ongoing MSc research I have uncovered differences in biodiversity between ownership types in Norwegian forests. The biodiversity measures have been quantified on three spatial scales, using different indicators: (1) landscape scale, using LIDAR data of forest structures; (2) habitat scale, using environmental inventories in forestry; and (3) species scale, using data on redlisted species.

I have also found an overall positive trend in site indices, an apparent pattern in distance to roads, and stand-out differences between municipalities. Additionally, I have observed a negative correlation between the percentage of biodiverse habitats and total forest area per owner, where some are linear trends and some are quadratic. Finally, I have collected questionnaire data from 263 forest owners in my study area, and looked for patterns related to ownership, forestry practises, goals, actors and the respondents' percieved influence over the forest management.

3

Global drivers of aquatic plant height

Yang Liu, Wuhan Botanical Garden/Lars L. Iversen, McGill University

Plant height is a major indicator of ecological fitness in both the terrestrial and aquatic realm. While terrestrial plant height decreases with latitude, with water availability and temperature as mains drivers, the large-scale-pattern and drivers of aquatic plant size remain unexplored. As aquatic plants have ample water supply, other large-scale environmental gradients such as temperature, water depth and inorganic carbon availability could influence the height of this organism group. Using plant heights, life-form information and global distribution for 1729 aquatic plants (emergent and submerged), we tested the influence of large-scale environmental drivers on plant community height. Emergent plant height decreased with latitude while submerged plant height showed the opposite pattern. Our models suggested that heights of emergent increases with temperature while heights of submerged plants are promoted by the supply of inorganic carbon and negatively influenced by temperature.

4

A single trophic structure characterizes Earth's communities

Luis F. Camacho & Miguel B. Araujo

Ecosystem energetics is tightly linked to the number of species it can harbor. Still, energy is neither static nor evenly distributed across ecosystems, and may, thus, also shape the trophic structure of ecological communities. In fact, ecosystem productivity has been shown to organize bird and mammal communities into distinct guild assemblages worldwide. Here we show, however, that despite such shifts in guild structure, a fixed trophic structure emerges globally composed of 18% primary consumers, 57% secondary consumers, and 25% mixed consumer species. This pattern suggests a self-organizing property of ecosystems independent of its energetics. We argue that this may be instead shaped by rules governing the trophic scaling of ecological space, which expands above the level of primary consumers and creates an inverted pyramid of species richness.

5

Predictive modelling of the distribution of the Tawny Pipit Anthus campestris at regional and continental scales

Miriam Vlachovičová, Institute of Landscape Ecology, SAS

Gaining an understanding of the distribution and habitat preferences of bird species is crucial for conserving their declining populations. The Tawny Pipit is an inconspicuous species that easily escapes attention. We have modeled the occurrence of this species at various scales. At the regional scale, presence-

absence data were utilized along with site surveys. At the continental scale, we employed presence-only data, using citizen science data (eBird). Our approach involved the use of several non-parametric classification algorithms available in Google Earth Engine (GEE), including random forest, support vector machine, classification and regression trees, maximum entropy, and gradient boosting by incorporating variables such as habitat, climate, and landscape features. Different models have yielded varying predictions of distributions, which could influence protected area allocation strategies.

7

Develop an AI model for evaluating insect diversity by environmental DNA (eDNA) techniques and malaise trap

Beilun Zhao Department of Organismal Biology, Uppsala University/Tobias Andermann Department of Organismal Biology, Uppsala University

Insects represent the most diverse taxon and play a crucial role in ecosystem ecology. However, their diversity and abundance are under threat due to human activities and global climate change. This project aims to develop an Artificial Intelligence (AI) model for swift and efficient insect diversity assessment, utilizing environmental DNA (eDNA) and the malaise trap method, in conjunction with publicly available climate and land use data. Approximately 600 environmental samples (seven types) were collected from 45 spruce forests across southern Sweden to realise this objective. Employing metabarcoding sequencing, insect species identification was conducted for each sample. The resultant data, combined with information on sample location, sampling date, and sample type, along with public climate and land use data, form the foundation for developing an advanced AI model.

8

What spatial quantitative digital tools are used to support the planning of green infrastructure for biodiversity?

Etsuko Nonaka Department of Sustainable Development, Environmental Science and Engineering (SEED) Royal Institute of Technology KTH, Stockholm, Sweden / Ulla Mörtberg Department of Sustainable Development, Environmental Science and Engineering (SEED) Royal Institute of Technology KTH, Stockholm, Sweden

Green infrastructure (GI) has become a frequently used spatial planning framework. It involves integrating natural and semi-natural green spaces into landscapes impacted by human activities to promote biodiversity. Planners often use quantitative digital tools to identify habitat networks to be maintained as GI. However, planning may be disconnected from ecological expert knowledge. This is because it needs to be completed relatively quickly, and digital tools are readily available. To understand the situation, we carried out a systematic survey of GI

planning literature. We found that GI plans considered widely different spatial extents and used a variety of approaches and software. While the empirical data on movement and habitat quality to parameterize the tools were scarce, habitat connectivity received a great attention. Given incomplete knowledge of species' demands on their landscapes, recognizing uncertainties and evaluating the performance of planned GI are crucially important

9

Adapting Fish Habitat Models for a Future of Novel Riverscapes

Henry H. Hansen, Karlstad University/ Eva Bergman, Karlstad University

Multiple anthropogenic forces have pushed river ecosystems into undesirable states. The advancement of riverine fish habitat models intended to provide management insights has slowed. Investigations into theoretical and empirical gaps to define habitat more comprehensively across different scales and ecological organizations are crucial in managing the freshwater biodiversity crisis. We introduce the concept of novel riverscapes to reconcile anthropogenic forcing, fish habitat, limitations of current fish habitat models, and opportunities for new models. We outline three priority data-driven opportunities that incorporate the novel riverscape concept: 1) fish movement, 2) river behavior, and 3) drivers of novelty that all are integrated into a scale- based framework to guide the development of new models. Last, we present a case study showing how researchers, model developers, and practitioners can work collaboratively to implement the novel riverscape concept.

10

Decadal change and future monitoring of boreal forest understorey communities

Tuuli Rissanen, University of Helsinki/Jukka Siren, University of Helsinki/ Raisa Mäkipää, Natural Resources Institute Finland/ Tiina Tonteri, Natural Resources Institute Finland/ Jarno Vanhatalo, University of Helsinki/ Anna-Liisa Laine, University of Helsinki

Boreal forests are facing vast changes due to the global environmental change and human land use. In Finland, forests cover over 75 % of the land area and their structure and resources are well monitored in continuous inventories. On the contrary, understorey vegetation is far less investigated even though the understorey communities form an important part of biodiversity and are crucial for ecosystem processes in boreal forests. Therefore, knowledge on broad-scale changes in the plant communities is highly needed in for both conserving and managing forest ecosystems. In this study we utilise understorey monitoring data from four surveys 1985-2023 that cover up to 1700 study sites across Finland to investigate spatial and temporal change in vegetation composition and diversity in relation to key environmental factors. Furthermore, we aim to identify potential indicator species

that could be monitored frequently to detect future changes in the understorey communities.

11

Biodiversity changes in drained Icelandic peatlands – are bryophytes an indicator of drainage and degradation state?

Ágústa Helgadóttir (1), Vigdís Freyja Helmutsdóttir (1), Sunna Áskelsdóttir (1). 1: Land and Forest Iceland

Icelandic peatlands have been extensively drained in past decades, and now efforts are being made to restore these endangered ecosystems. Because of their prominence, vascular plants have overshadowed bryophytes in peatland research in Iceland. Therefore, it is unknown how drainage affects the cover and species composition of bryophytes. In spring of 2023, a field study was conducted with 40 plots located in SW Iceland. The main aim was to monitor greenhouse gas fluxes from peatlands in diverse conditions, in relation to scales of drainage, land use, distance from the sea and proximity to active volcanic zones. Other assessed factors included habitat types, vegetation cover and plant species composition, and an attempt was made to evaluate the level of degradation state. At first glance, bryophytes appear to be sensitive to disturbance, and their abundance and species composition are good indicators of the level of peatland degradation.

12

The role of geodiversity climate-wise conservation planning

Aino-Maija Määttänen, University of Oulu / Julia Kemppinen, University of Oulu / Maria Hällfors, Finnish Environment Institute / Jan Hjort, University of Oulu

Ensuring habitat connectivity is recognized as a climate-wise conservation strategy as this promotes gene flow and viable populations thus making species more resilient in the face of climate change. While protected areas serve as refugia, their efficacy is hindered by surrounding land use and habitat degradation. Geodiversity sets the stage for biodiversity by introducing landscape variations like diverse topography and providing microclimate heterogeneity for species and their interactions. This complementary role in nature conservation is evident and geodiverse landscapes are anticipated to be more resilient to climate change. However, studies incorporating geodiversity layers into connectivity modeling are scarce, highlighting the need for a more comprehensive understanding of their interplay in conservation strategies. In this poster I will present preliminary results of my PhD research on how to incorporate measures geodiversity in connectivity models in a meaningful way.

13

Understory development in 60 years chronosequences of oak, beech and Norway spruce on afforested agricultural soil

Davide Barsotti, Department of geosciences and natural resource management, University of Copenhagen / Sebastian Kepfer Rojas, Department of geosciences and natural resource management, University of Copenhagen / Inger Kappel Schmidt, Department of geosciences and natural resource management, University of Copenhagen

The ongoing afforestation in Denmark is limited to agricultural soils. It has the potential to provide ecosystem services and habitats for specialist species. However, land use legacies and fragmented landscapes hinder the recovery of forest-specialized biodiversity.

We investigated the development of ground vegetation in forest stands surrounded by anthropic landscapes. We compared the effects of abiotic factors and dispersal constraints in beech, oak, and Norway spruce chronosequences spanning 60 years since the abandonment of agriculture, based on three vegetation surveys over the last two decades. Our results show an initial rapid species turnover dominated by fast-dispersing generalists and a slow appearance of forest specialists. Surprisingly, the differences between tree species were only marginally significant. Despite the importance of abiotic agricultural legacies for the plant community, dispersal came out as the main constraint for forest-associated species recovery.

14

Ants in old and new managed forests: risks and opportunities for biodiversity.

Emil Andersson, The Swedish University of Agricultural Sciences, SLU/Emma Holmström, The Swedish University of Agricultural Sciences, SLU/ Lisa Petersson, The Swedish University of Agricultural Sciences, SLU/ Therese Löfroth, The Swedish University of Agricultural Sciences, SLU

The Formica rufa-group, known as Red wood ants (RWA), have been suggested as flagship species due to the eye-striking size of their mounds, which also constitutes a microcosm for ant-guests and other associated organisms. Therefore, even though RWA are not considered threatened in Sweden, effects on their population densities could impact forest biodiversity. RWA are known to be negatively impacted by clear-fellings, but could changed forestry practices - such as saving retention trees, or the expected large increase in stands of fast-growing broadleaves - instead promote them?

In our studies we approach this question from multiple angles: We match forest data from the Swedish National Forest Inventory (NFI) with occurrence of RWA mounds to investigate the effect of past forest management; the NFI results can then be compared to surveys of RWA occurrence in stands of birch, poplar and

hybrid aspen; and we experimentally test the effect of saving retention trees around RWA mounds.

15

The biospheric emergency calls for ecologists to change tactics

Fernando Racimo, University of Copenhagen, Denmark / Elia Valentini, University of Essex, UK / Gaston Rijo De León, Institut Pasteur, France / Teresa L. Santos, Universidade de Lisboa, Portugal / Anna Norberg, Potsdam Institute for Climate Impact Research, Germany / Lane M. Atmore, University of Oslo, Norway / Myranda Murray, University of Oslo, Norway / Sanja M. Hakala, Université de Fribourg, Switzerland / Frederik Appel Olsen, University of Copenhagen, Denmark / Charlie J. Gardner, University of Kent, UK / Julia B. Halder, Imperial College London, UK

Our current economic and political structures have an increasingly devastating impact on the Earth's ecosystems and climate: we are facing a biospheric emergency, with catastrophic consequences for both humans and the natural world on which we depend. Ecologists have had a crucial role in documenting the impacts of this emergency, but have failed to drive governments to take action in order to prevent the situation from getting worse. Here we, as concerned scientists and members of the movement Scientist Rebellion, call on them to re-embrace advocacy and activism – which were once hallmarks of academia – in order to highlight the urgency and necessity of systemic change across our societies. We particularly emphasize the need for scientists to engage in civil resistance: a form of public engagement which has proven to be highly effective for building counter-power, and advancing social and ecological struggles throughout history.

16

Estimating the effectiveness and time lags of restoration and conservation actions for ecological compensation

Eini Nieminen, University of Jyväskylä / Aapo Ahola, Finnish Environment Institute / Heini Kujala, University of Helsinki / Atte Moilanen, University of Helsinki / Janne Kotiaho, University of Jyväskylä

Ecological compensation (biodiversity offsetting) aims at compensating development projects' biodiversity losses by restoring and/or protecting nature elsewhere so that No Net Loss (NNL) for nature would be reached. Compensation areas required to reach NNL however would, and should, depend on the effectiveness and time lags of the selected restoration and protection actions, which is rarely the case in national compensation systems. Here I present the Finnish project for defining metrics to assess ecosystem types' ecological condition and estimates for how different restoration actions improve their condition. In total, 201 response estimates for ecosystem type/restoration action pairs were defined in a large-scale expert collaboration. They will form the basis for the official ecological compensation in Finland, which came possible in 2023 in the revised Nature

Protection law. Response estimates benefit restoration planning also outside the compensation context.

17

Advancing conservation of biodiversity by investigating spatial phylogenetics of plants in Páramo Colombia

Kamal Hossain (NTNU)/ Sarah L. Martin (NTNU)/ Alejandro Zuluaga Trochez (Herbarium of the Universidad del Valle, CUVC) / James D. M. Speed (NTNU) / Michael D. Martin (NTNU)

The high Andean Páramo is an important, biodiverse ecosystem threatened due to land use changes such as agriculture and mining. To improve understanding the evolution and spatial distribution of the plant diversity, we investigated the spatial phylogenetics of the ecosystem, quantifying the phylogenetic diversity across the ecoregion. We combine publicly available genetic sequence data and novel genetic data derived from vascular plant specimens in Colombian herbaria to generate a phylogeny of all vascular plant genera of Colombian Páramo. We next integrate this with occurrence data from GBIF to map the distribution patterns of the Páramo genera across the entire Colombian Páramo. Our approach identifies centres of neo- and paleo- endemism across the Páramo region and identifies threatened taxonomic groups for guiding conservation efforts. This process will create a scope to prioritizing certain areas for protection and identify biogeographical patterns in the Colombian Páramo regions.

18

Can sheep husbandry re-valorize abandoned mountain rangelands?

Marta Ruzzier Agricultural University of Iceland/ Alberto Tamburini Università degli studi di Milano-Dipartimento di Scienze Agrarie e Ambientali/ Andrea Messa Progetto PAN Prat

The recent population increase in mountain areas calls for finding rural practices that provide sustainable lifestyles. Sheep husbandry could be a solution, as sheep are rustic, highly adaptable animals that can feed on low quality pastures and cope with cold temperatures. This study provides an agronomic evaluation of the management of a small flock of sheep reintroduced in the valleys of Bergamo Alps, in northern Italy, to re-valorize mountain rangelands through an extensive farming system with rotational pastures. The flock was mostly fed pasture grass and hay. Sheep were weighed to calculate daily weight gains. Plant samples were collected to value forage quality and whether forage met the sheep's nutritional requirements. Animal growth was adequate and forage fulfilled the animals' nutritional requirements. The findings suggest that this type of farming could valorize mountains; it could also suit other northern rangelands where extensive sheep grazing is an important land use.

19

Exploring the impact of reed (Phragmites australis) management techniques on fish communities

William Ashworth / Swedish University of Agricultural Sciences, Department of Aquatic Resources, Uppsala, Sweden / Niklas Niemi / Swedish University of Agricultural Sciences, Department of Aquatic Resources, Uppsala, Sweden / Örjan Östman / Swedish University of Agricultural Sciences, Department of Aquatic Resources, Uppsala, Sweden

The common reed (Phragmites australis) is an emergent stand forming macrophyte which grows at the intersection between land and fresh or brackish water. It's resilient nature combined with a rapid ability to assimilate nutrients has facilitated reed to spread and form monocultures, particularly in eutrophic environments. Such monocultures are not only detrimental to the biodiversity of other macrophytes, but also interacting organisms such as fish, birds and invertebrates, who depend on a heterogeneous environment. Several forms of reed management have been utilised with the aim of restoring the natural ecosystem biodiversity and heterogeneity. In this study, we compare how three management techniques, clear cutting, cutting channels and water buffalo grazing influence the biodiversity of local fish communities compared to reference areas. We believe the results of this study can help guide future management decisions on how best to restore biodiversity in reed dominated ecosystems.

20

Landscape-scale land-use composition effects on invertebrate herbivory in semi-natural grasslands

Yuanyuan Quan1, Veronica Hederström1, Theresia Krausl1, and Yann Clough1 1Centre for Environmental and Climate Science, Lund University, Lund, Sweden. Correspondence: Yuanyuan Quan (yuanyuan.quan@cec.lu.se)*

This study assessed invertebrate herbivory across 51 plant species in 18 Southern Sweden field sites, each with varying land use compositions. Analyses focused on plant traits, diversity, and composition to understand the impact of land use changes on herbivory. Results showed permanent grassland significantly influenced herbivory, with increased leaf and stem damage in areas with more grassland and decreased damage with more arable crops. However, effects varied among species, indicating the importance of considering plant community context in land use change studies, underscoring the role of permanent grasslands in maintaining ecosystem functionality.

21

Potential differences in 13C:15N ratios across different morphotypic- and/or taxonomic ectomycorrhiza in Norway spruce

Elise Blum Samuelsen, Terrestrial Ecology Section, Department of Biology, University of Copenhagen, Denmark / Andrea Therese Kaaber, Terrestrial Ecology Section, Department of Biology, University of Copenhagen, Denmark / Anders Michelsen, Terrestrial Ecology Section, Department of Biology, University of Copenhagen, Denmark / Rasmus Kjøller, Terrestrial Ecology Section, Department of Biology, University of Copenhagen, Denmark

Trees and fungi have coevolved mutualistically, enabling trees access to organically bound nutrients from the soil, and fungi access to photosynthetically fixed carbon, which is exchanged between them at the ectomycorrhizal interface. In this field study, we aim to investigate nutrient exchange between partners of the ectomycorrhizal symbiosis in Norway spruce. By isotopically labelling individual seedlings with 13C and 15N, above and belowground, respectively, we aim to reveal potential differences in 13C:15N ratios (and hence ecological function) of different morphotypic- and/or taxonomic fungal groups, using morphotyping, molecular analysis and isotope-ratio mass spectrometry of colonised roots. The experiment was conducted in a naturally regenerating forest, allowing us to explore challenges of ecological processes affecting the interactions. These insights may help broaden the understanding of fundamental ectomycorrhizal ecology in relation to taxonomic and functional diversity.

22

Effects of CMN complexity on inter-plant carbon transfer

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Arbuscular-mycorrhizal (AM) symbiosis is one of the most ubiquitous mutualisms on Earth. Many studies investigating AM and CMNs have looked into plant nutritional benefits, community fitness or asymmetric resource allocation, yet they focused mainly on the plant-centered approach. In this study, perspective is shifted to the fungal side, asking how the properties of CMN itself, e.g. structural complexity, affect AM functioning and inter-plant communication. Differing inoculum potentials were employed to obtain different CMN structural complexity levels to study their effects on the quantity of carbon (C) transferred from donor plant to receiver. Shading was applied to enhance directional C transfer, and fluxes were tracked using 13C labelling. Higher amounts of C are expected to be transferred from source to sink plant through a more complex hyphal network than a less complex one, suggesting that the properties of the system may shape the functioning of AM and should not be overlooked.

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De Novo Synthesized Pyrazines in Tiger Moths: Ecology, Evolution and Prevalence

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Predation significantly shapes the evolution of prey species, influencing their traits, behaviours, and adaptations. Defensive toxins are a common strategy used by organisms to deter natural enemies. Pyrazines, nitrogen-containing compounds with odour properties, are used to repel predators and are found in various organisms such as plants, insects, fungi, and bacteria. Recently, it has been discovered that some insects can produce pyrazines de novo, which may significantly reduce the costs associated with searching for external resources. We aimed to determine the prevalence of this phenomenon among Arctiinae moths, a well-known group that commonly employs aposematism in their defence strategy. Our preliminary findings indicate that pyrazines are limited to two genera of Arctiinae, exclusively found in the Holarctic region. We will discuss the ecological factors that have influenced the evolution of these defensive strategies within this group.

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Do diel patterns of scent emission in alpine rock-cress correlate with peak pollinator activity?

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Floral scent is a known pollinator attractant in many systems. Plants should emit more scent while their main pollinators are active, assuming floral scent is biosynthetically or ecologically costly to produce. Further, plants may regulate the specific compound compositions emitted at different time periods. However, floral scent does not only very temporally but also spatially among flower tissues. Compounds emitted from the reproductive organs typically have multiple functions both as pollinator attractants and herbivore repellents, while compounds emitted from petals may have a more attractive function. In a pollination-generalized plant (Arabis alpina), we documented the diel patterns of scent emission and performed field pollinator exclusion experiments to investigate whether this species regulates scent emissions according to pollinator activity. We also investigated qualitative differences between day and night, as well as between floral tissues.

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DNA barcode library for the dune heath flora of Thy National Park: precision and applicability in biodiversity monitoring

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Thy National Park is dominated by coastal sand dunes and dune heath. These dynamic landscapes make up ever-changing patchworks of habitat types, necessitating frequenct monitoring. Molecular plant identification may aid trained botanists in monitoring biodiversity change in dune ecosystems by enabling identification from fragments, enhancing accuracy and extending the monitoring season. This research evaluates the precision of molecular plant identification. We gathered herbarium specimens and leaf samples for DNA analyses from 100 species and created a DNA barcode library using rbcL sequences. A clear barcode gap existed between most species, and NJ analyses successfully clustered individuals from the same species. Molecular plant identification is hence viable and a precise tool to assist biodiversity monitoring. Ongoing research will test this conlusion by employing molecular plant identification in biodiversity monitoring through inventory of 16 permanent plots in dune heaths.

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Why do oaks (Quercus spp.) have lobed leaves?

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Lobed leaves are a characteristic feature of oak trees (Quercus L., Fagaceae) although only a subset of the more than 400 species do possess such leaves. Oaks became abundant in the northern hemisphere during the early Eocene (ca. 50 million years, myrs, ago) but the first records of deeply lobed leaves are only known from Oligocene deposits, at least 15 myrs later. Lobed leaves started to radiate during the Eocene-Oligocene transition (EOT, ca. 34 myrs ago), which denotes the most dramatic global drop in temperature during the past 65 million years. We aim to assess how lobed leaves and other leaf characteristics are distributed across the global oak phylogeny and how their distribution is constrained by climate. To do this, we compiled leaf traits and climate envelopes for all modern oak species. We then used the extensive leaf fossil record and past climate reconstructions to trace the origin of lobed oak leaves.

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Patterns of cross-taxa diversity and composition of benthic communities in response to river restoration

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Exploring the patterns of diversity and community composition across evolutionary and functionally diverse organisms is critical to understanding the general processes that influence and shape biodiversity. This can provide effective information for the management of freshwater ecosystems. Here, we present a cross-taxa assessment of benthic macroinvertebrates and sediment-associated microbial communities profiled from metabarcoding-based surveys for evaluating the habitat restoration of a dam-fragmented river. We estimated diversity and community composition indices and employed multivariate analyses to quantitatively assess overall congruence in response patterns to dam fragmentation and gravel bar restoration among the benthic communities and the functional potential of microorganisms in the Trinity River, California, USA. Our findings have important implications for river restoration strategies and the protection of benthic communities in similar environments.

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Was Darwin right? Testing intra- and interspecific competition in Acrocephalus warblers

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Darwin suggested that species' ranges are delimited by abiotic factors in the north, whereas closer to the equator biotic factors such as interspecific competition are key. We measured strength of local territorial competition in habitat specialist warblers to test the relative importance of abiotic and biotic predictors on reed warbler (Acrocephalus scirpaceus) occurrence in Europe. In 2023, we presented mounted and 3D-models of Acrocephalus species with song playback at reed warbler nests at their northern range edge in Finland. Expectedly, reed warblers showed little interest in subordinate A. schoenobaenus and responded to conspecifics, but behaviour towards less common competitors (A. palustris and A. arundinaceus) varied. Taxidermic and 3D-printed models yielded similar

responses, supporting the use of 3D-models in experiments. In 2024, we will repeat the experiment at the range core and southern edge to test whether Darwin's theory holds under changing climate and communities.

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Moth bottom-up effects on insectivorous birds only show up in the north-boreal region of Finland

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Insect declines raise concerns about ecosystem impacts, notably on insectivorous birds. Here, we leveraged long-term monitoring datasets across Finland to investigate trophic dynamics between functional groups of moths and birds. We revealed abundance of adult- or egg-overwintering moths show positive association with abundances of resident and long-distance migrant birds that rely on caterpillars as breeding-season food in the north-boreal zone. Contrary to expectations, similar signs of moth bottom-up effects on insectivorous birds were not found in other regions, or by moths overwintering in other life stages. In fact, there were even some negative associations between moths and birds, possibly due to their opposite abundance trends in Finland. While supporting the existence of bottom-up effects in the north-boreal zone, our study also emphasizes the need for further investigation to comprehensively understand moth-mediated trophic dynamics in areas where insects constantly decline.

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Diversity and distribution of ericoid mycorrhizal fungi and their role in dwarf-shrub carbon, nutrient and water cycling

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The boreal, alpine, and arctic heaths and forests are dominated by dwarf-shrubs along with their symbionts, ericoid mycorrhizal fungi. Dwarf-shrubs are sensitive to climate change and are already affected in large-scale diebacks. It remains to explore how their mycorrhizal symbionts mitigate damages, since little is known about these plant-fungal interactions. Their symbiosis can increase carbon storage, and water and nutrient uptake in the host plant. Further research on ericoid mycorrhizal fungal diversity, distribution, and physiological cycles can aid in predicting future climate change responses. The DURIN project focuses on dwarf-shrubs and their responses to climate via physiological and ecosystem processes, species interactions and how processes at all these levels may impact feedbacks to the climate system. My role is to address major knowledge gaps on ericoid mycorrhizae by doing experimental and observational studies along a climatic gradient in Norway.

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Fungal species maintain mycelial morphlogy despite attack by fungal grazers

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Mycelial morphology represents the foraging phenotype of fungi. However, due to the belief that the mycelial morphology as a trait is extremely plastic, changing in response to environmental conditions, it has been ignored to understand the foraging ecology of fungi. Here, we showed that mycelial morphology of four fungal species kept key species level distinctions even after being grazed by different types of grazers. In particular, traits related to the mycelial architecture of major transport roads were little influenced by grazing. Our study shows the value of the study of mycelial morphology as a valuable way to understand the foraging behaviour of fungi.

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Earthworm-microbe interactions: what can we learn from controlled earthworm introduction into boreal forest soil?

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While creating the drilosphere, earthworms interact with microorganisms and thereby greatly affecting soil carbon and nutrient cycling. However, interactions between earthworms and soil fungi are poorly understood, and the mechanisms by which earthworms affect these microorganisms are challenging to study. Given the widespread presence of earthworms, finding soils that have not been previously affected by them is difficult and controlled laboratory incubation experiments often exclude e.g., plant-associated fungi. In our project, we established mesocosm boxes filled with soil turfs including tree saplings from northern boreal forests and placed them in an experimental forest in southern Sweden. We will introduce soil-dwelling earthworms into the mesocosms and measure changes in microbial communities using RNA and DNA sequencing which we will relate to measurements of carbon and nitrogen cycling, such as carbon-dioxide flux measurements and soil mineral nitrogen content analysis.

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PhD research plan for project: Untangling the role of fungal network morphology in soil carbon dynamics

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Uncovering new methods to mitigate climate change is of increasing urgency. In soil, such as crop-fields, there is unused potential for both prolonging and increasing the persistence of carbon therein. To unlock this potential, it is essential to understand how soil fungal diversity influences transformation and respiration rates of soil carbon. There's limited knowledge regarding how the morphological diversity of fungi, specifically their mycelium, affects the persistence of carbon in soil. Mycelial morphology (MM) represents the primary phase during which fungi utilize soil carbon for respiration and biomass integration. This project aims to assess the significance of differences in MM in explaining Carbon Use Efficiency (CUE). The approach involves measuring MM and carbon-acquisition traits across fungal species, identifying scaling relationships, and comparing species to identify functional groups, -traits, and ass. genes explaining soil CUE in both lab and boreal forest settings.

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Small populations, big challenges: Population vitality in Primula elatior affected by genetics, demography and landscape

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Small populations can suffer from reduced plant fitness as a consequence of both genetic and demographic processes. This study investigates the relationships between population size, genetic diversity, floral dimorphism and reproductive fitness in 33 wild populations of Primula elatior in the Netherlands. Genetic diversity was assessed by using a genotyping-by-sequencing approach. In a subset of populations, pollinator surveys were conducted to study how pollinator abundance and adjacent land use affect seed set. Our results revealed five spatially distinct genetic clusters. Larger populations had higher genetic diversity, more balanced flower morph ratios and higher flower densities, advancing seed set and seedling densities. Seed set was limited by pollinator abundance and displayed a unimodal relationship with forest cover within 1000 meters around the survey site. This study illustrates how genetic and demographic processes can both contribute to the decline of plant populations.

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Testing Flash Coloration in Wild Avian Predators: Delayed Detection of Conspicuous Prey in Motion.

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Coloration serves diverse functions in the natural world, from extravagant mating displays to camouflage. While protective coloration has been extensively studied across taxa, empirical testing of color's function in moving prey presents inherent challenges. Here, we employ a novel Touchscreen Operant Chamber (TOC) to investigate how wild avian predators respond to prey exhibiting flash colouration, in which conspicuous colours are only visible when in motion; this 'flashing' is thought to bewilder pursuing predators. Our research reveals a significant delay in the detection of prey displaying conspicuous colors during evasion, supporting the classic tenets of flash coloration theory. While previous research has centered on anatomy-based ecological predictions and experiments using humans, our study provides pioneering empirical support for flash coloration in the context of wild predators. This sheds new light on the complex interplay between prey coloration and predator behavior.

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Breeding dispersal in an endangered sea duck under increased predation risk

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Breeding dispersal, i.e., movement between successive breeding sites, is poorly understood. Breeding dispersal may aid predator avoidance if individuals adopt a 'win-stay, lose-switch' strategy, but it also depends on individual traits. We studied the drivers of breeding dispersal of female common eiders (Somateria mollissima), a ground-nesting duck with high site-fidelity, during 21-years (2003-23) in SW Finland, Baltic Sea.

Predation on this population has increased dramatically, which led us to expect increased dispersal over time. We used long-term data on individual traits and environmental factors, to clarify which factors affect dispersal, based on GPS data on nest locations of known individuals. We also analysed the probability of changing breeding colony and whether such change was directed toward mainland with less intense eagle predation. Preliminary results suggest that breeding dispersal was mainly determined by breeding success and adult predation risk.

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Trophic pathways of heavy metals in Artic marine food webs

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Benthic and pelagic macroinvertebrates play a key role in Arctic food webs,

regulating the quality and availability of energy for higher trophic levels. Acquiring data on heavy metals and trophic structures is critical to understand the dynamics influencing Arctic species, including fish, and therefore the quality of human food. We investigated metal pathways in an Arctic marine food web. Heavy metals (Hg, V, Cr, Co, Ni, Cd, Sn, Pb, As, Ba, Fe, Mn, Cu, Zn) and stable isotopes of carbon (δ13C) and nitrogen (δ15N) were measured in benthic and pelagic species from Belgica Bank (Greenland). Among others, Hg increased linearly with δ15N and trophic position of organisms and was highest for the benthic predator Volutopsius norwegicus (1.334 ± 0.037 µg/g) and lowest for the pelagic amphipod Themisto libellula (0.058 ± 0.002 µg/g). These differences between compartments should be considered when aiming to understand pathways of contaminants within Arctic food webs and when planning fisheries.

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Behavioural syndromes in Asellus aquaticus: From behaviour and metabolic rate studies to environmental risk assessments

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Environmental pollution is often characterized by low-dose, chronic exposure regimes. We hypothesize that non-conventional endpoints like behaviour may capture more subtle effects of pollution and that variability in behaviour may be used to predict effects at population and community level. These changes in variability may have profound effects on species interactions and population dynamics.The aim of this project is to assess impact of low-dose chronic exposure of an antidepressant fluoxetine, and a metal copper on behaviour and metabolism in populations of the freshwater isopod, Asellus aquaticus and to incorporate findings into environmental risk assessments. Here, we present results from the first step where behaviour and metabolic rate of wild-caught A. aquaticus was quantified without exposure to chemicals. We tested associations among behaviours i.e., behavioural syndrome, repeatability, and if behaviours were correlated with metabolic rate i.e., the pace-of-life hypothesis.

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Integrating ecological and evolutionary principles to stabilize the evolutionary potential of a fungal pathogen

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Fungicide resistance is an evolutionary response in the pathogen to the directional selection exerted by the continued use of fungicides. To mitigate the spread of fungicide resistance, plant protection strategies aim to combine ecological and evolutionary principles, to exert fluctuating selection and stabilize the evolutionary

potential of the pathogen. The fungal pathogen Alternaria solani, causal agent of early blight disease in potato, is quickly evolving resistance to the commonly used fungicides. We therefore aim to deepen ecological knowledge of A. solani both within- and between- epidemic phases of its life cycle. We are correlating landscape features with disease severity, and A. solani dispersal together with studying the effect of soil nutrients, microbial community composition and drought on its overwintering survival. The goal is to find sustainable crop protection methods that ease fungicide dependence, for a sustainable management of A. solani.

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Mate Choice and the Maintenance of Color Polymorphism in the Wood Tiger Moth (Arctia plantaginis)

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Mate choice among morphs can play a pivotal role in the maintenance of complex color polymorphisms. In the wood tiger moth (A. plantaginis), males exhibit polymorphism in hindwing coloration: individuals with one or two dominant W (WW) alleles have white coloration, while those with two recessive y alleles (yy) display yellow coloration. We investigated differences in mating success among the male morphs in two experimental settings: presenting a female with two males of different morphs, and in a more natural context with multiple females and males present. Our findings revealed that WW males had a significantly higher likelihood of copulation compared to yy males in both settings. Intriguingly, WW males did not exhibit a higher reproductive output. Instead, we found a heterozygote advantage in reproductive success. These results underscore the significance of mate choice in maintaining color polymorphism, emphasizing the interplay between pre- and postzygotic selection mechanisms.

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Rapid temporal adaptation structures Daphnia magna's tolerance to toxic cyanobacteria

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Cyanobacterial blooms globally affect aquatic ecosystems and adversely impact the zooplankton grazer Daphnia and its ability to maintain a clear water state. We therefore investigated Daphnia's adaptation potential to Microcystis sp. over two consecutive years in a single pond. Daphnia clones and Microcystis strains were collected at two time points in the growth season (April vs. May/June), and exposed in synchronous and asychronous combinations. Our findings reveal strong statistical support for a higher survival in synchronous combinations, a pattern observed in both years. In addition to these temporal dynamics, we identified important effects of Daphnia and Microcystis genotype on survival, with Daphnia clones displaying varying sensitivity and Microcystis strains displaying varying toxicity. Our results suggest the existence of strong and fast-paced red queen dynamics underlying the tolerance of zooplankton grazers to cyanobacteria.

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The many faces of an aging germline

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Germline mutations are the ultimate source of genetic diversity and the fuel for evolution, and germline mutation rate (GMR) is thus central to evolutionary biology. However, while GMR is known to increase with parental age, this effect (parental age effect) is not fully understood. Specifically, some studies report a positive linear relationship of GMR with increasing age, but others suggest that GMR varies with age non-linearly.

To precisely characterize parental age effect, we employed a mutation accumulation approach (MA) in a nematode and a pedigree-based approach (PD) in a superorganism. GMR was derived at young, prime, and old parental ages after three generations of mutation accumulation (MA) or from offspring produced at each parental age (PB). Results from both approaches show that prime parental age had a reduced mutation rate compared to young and old ages. The non-linear increase in offspring mutation load with age likely represents selection against germline senescence.

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Effects of elevated yolk testosterone levels on growth, breathing rate and survival in great tit nestlings

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Embryo exposure to maternal hormones varies with environmental or maternal factors. In avian eggs, yolk androgens play a main role in post-natal offspring development, but few studies have examined their dose-response effects on the cost-benefit balance in early-life. We explored the dose-dependent response to maternal androgens by injecting two different testosterone (T) doses into the egg yolks of wild great tits. Our results show no effects of T on chick weight or morphometric traits. Body condition was affected by egg volume and sibling competition. However, chicks hatched from eggs receiving the highest T-dose had higher breathing rates. Hatching success did not differ between treatments. The higher T-dose favoured nestling survival during post-hatching development, while we found no evidence for a prenatal T effect on post-fledging survival. Future studies should carefully consider a range of concentrations, as the cost-benefit balance of prenatal hormones may be dose-dependent.

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Road verges as habitat for pollinating insects – effects of management and traffic

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Road verges cover vast areas and might provide an opportunity for conservation of species associated with declining semi-natural grasslands, including pollinating insects. However, it is unclear to what extent road verges support the same set of species as semi-natural grasslands, and if this depends on their management and on the traffic intensity on the adjacent road. We 1) compared species richness and community composition of butterflies and bumblebees in road verges and semi-natural grasslands in the same landscapes, and 2) used a crossed study design to disentangle the effects of management and traffic on bee and butterfly communities in road verges. Road verges had similar numbers of species as semi-natural grasslands, but only partly the same set of species. Pollinator diversity along roads increased with plant diversity and flower abundance, but these effects were reduced along roads with high traffic intensity.

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Plants and pollinators in urban flowerbeds: the selection of plant species matters for optimizing interactions

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Pollinators are functionally important, but in a world that become increasingly urbanized, their natural habitats are in decline. However, manmade green areas contribute to sustaining insect populations in highly urbanized areas.

This study investigates the effect of different flowerbed characteristics on pollinating insects in public urban parks to find ways to make urban parks better able to sustain pollinators. The richness and abundance of pollinators and plants, in addition to the interaction between the two, were recorded during four field periods during the summer of 2023. Two different types of flowerbeds were used across 7 sites in Trondheim, Norway.

The study has identified plants of value for different pollinators in flowerbeds and preliminary results indicate that perennial flowerbeds attract more insects than short-lived flowerbeds. The results of this study will provide insight into how to better structure urban flowerbeds to provide suitable environments for pollinators.

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Mutualistic coevolution shape network structures at local and landscape scales

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Ecological interactions connect populations of different species locally, while dispersal between localities connect populations regionally, forming metacommunities. In a metacommunity, environmental filters and dispersal limitations can alter the patterns of interactions. Nevertheless, evolutionary processes also shape community structure and composition. Understanding how these eco-evolutionary and spatial dynamics shape the structures of local and regional networks in a metacommunity is necessary to comprehend how ecological systems respond to environmental changes. Here, we use a model of metacommunity dynamics that integrates evolution and mutualistic coevolution in space to comprehend the effects of coevolution on the structure of local and regional networks. We found that the strength of coevolution can shape local and regional networks in different ways, changing the relative importance of environment and dispersal processes on the network structure and composition.

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The role of networks in flower (co)evolution: Lithophragma bolanderi and its specialized and generalized pollinators

Pamela C. Santana1/Magne Friberg1 1 - Adaptation, Speciation and Coevolution (SpACE) group, Biodiversity Department, Lund University

In ecological communities, species interactions may generate evolutionary change, either through direct or indirect interactions. Lithophragma bolanderi and Greya politella represents a coevolved interaction, in which moths pollinate L. bolanderi flowers while ovipositing into the floral ovaries. However, the importance of G. politella for pollination is relative to the abundance of co-pollinators and co-flowering plants, indicating that the community network may affect the strength and direction of selection both directly and indirectly. Lithophragma bolanderi is visited by a broad spectrum of visitors, including dipterans, hymenopterans and lepidopterans. We sampled two populations of L. bolanderi collecting data on how plant fitness variation depend on the flower morphology, the surrounding plant community and the local network of interaction. In this talk, I will show initial results on how coevolutionary dynamics may be affected by the surrounding plant and pollinator community.

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Rewiring potential of plant-bird pollination networks in the Americas

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Interaction rewiring occurs via interaction turnover and strength changes, and it may mitigate global change effects on nature's functions. To understand the large-scale variation in rewiring potential, we quantified functional interaction niche breadths in mutualistic plant-bird pollination networks in the Americas. For all possible pairs of 1055 flowering plant and 318 hummingbird species, we fitted a trait-based machine learning model to predict interaction probabilities. We also inferred species' occurrences from range maps within 50x50km grid cells and combined them with the interaction probabilities to obtain local networks. For these networks, we quantified rewiring potential by calculating functional richness of predicted interaction partners. The rewiring potential of plants decreased with network specialization, but was not associated with the rewiring potential of birds. Networks with high rewiring potential may have a better chance to adapt to intensifying global change.

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Interplay between population mating system and temporal variation of pollination reliability in Dalechampia vines

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In plants with mixed mating systems, how interpopulation variation in mating system and its associated floral traits are related to temporal changes in pollination reliability remains unclear. Using multiyear data from tropical Dalechampia vines, we propose a framework to link interpopulation variation in local mating system with temporal changes in pollination reliability. We show that highly herkogamous (i.e. more outcrossing) populations exhibit greater absolute change in pollination reliability between years than populations with low herkogamy and more prone to selfing. However, the latter populations experienced higher proportional annual changes in reliability with greater fitness losses when pollination was unreliable. We suggest that the locally adapted mating system of a population likely reflects long-term pollination reliability, with traits facilitating selfing being more advantageous for populations exposed to severe fluctuations in the pollination environment.

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How important are short- and long-tongued bumblebees for red clover pollination?

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Red clover is a common forage crop grown in leys in many temperate parts of the world. One challenge in red clover production is low and varying seed yield, causing problems for seed farmers. Pollinators, mainly bumblebees and to some extent honeybees, are crucial for seed set in red clover. It has been proposed that especially declines of long-tongued bumblebee species is one of the causations behind low seed yields in red clover. We investigated the role of short- and long-tongued bumblebees for seed yield across six sites in Sweden. The results showed that long-tongued, but not short-tongued, bumblebees were important for seed yield. In another study with cage trials, the results showed that the short-tongued Bombus terrestris are able to contribute to high seed yield levels. Our study show that in field conditions, long-tongued species are the most important pollinators of red clover. However, B. terrestris are also able to pollinate the flowers when given no other forage options.

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Busy as a bee – what makes a good pollinator of apples?

Linn Vassvik (NIBIO/NMBU)/Erik Aschehoug (NMBU)/Bjørn Arild Hatteland (NIBIO)/Michael Garratt (University of Reading)/Joseph Chipperfield (NINA)/Anders Nielsen (NIBIO)

horticultural systems are increasingly reliant on managed honeybees for pollination services, however, honeybees are less effective pollinators than wild bees. Thus, pollination services within horticultural systems may be suboptimal. Effective pollinators of apples have been shown to differ in their morphological and behavioural traits, therefore maintaining a diverse pollinator community is important. We investigated (1) which species of bees are commonly present in apple orchards, (2) how do they behave, and (3) how do various pollinator communities affect apple quality? The study was conducted in Norway, where we collected pollinators using pan traps and observed pollinator activity on apple flowers directly during the flowering season, and in fall we harvested apples and measured quality parameters. Here, we present the first results obtained from this study.

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Flower preference as a response trait affecting wild bee community structure along a latitudinal gradient

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A broad functional diversity of bees contributes to the maintenance of plant biodiversity because different species of wild bees prefer and pollinate different plants. Many bees with narrow flower preferences are threatened. We still lack an understanding of the anthropogenic impacts on the distribution of wild bee species with a broad range of different flower preferences across a large spatial scale. Here, we observed an association between bee species with specialised flower preference towards either deep flowers (including Fabaceae) or plants with narrow flowers (Apiaceae/ Asteraceae/ Brassicaceae). Based on this continuous flower preference trait, we observed a large-scale species compositional turnover along a latitudinal gradient with large variation in temperature, N deposition and elevation.

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Managing lawns for biodiversity: the impact of mowing on plants and pollinators

Pooja Subedi

Private and public lawns cover extensive urban areas, but mowing can impact plants and pollinators and their interactions. The aim of the study is to compare the

composition of plants and pollinators in mowed and unmowed public lawns and todetermine which plant species are used by different pollinator groups. The study was conducted in Trondheim, Norway across six sites at 4 stages from mid-June to mid-August. We examined how mowing and seasonal variations impact the abundance and richness of plants, pollinators and the interactions between them. We found that pollinator abundance correlated with plant abundance in both mowed and unmowed lawns. The plant pollinator interaction peaked in late July. Mowing significantly affected the abundance of pollinators. Strategic mowing timing avoiding peak flowering periods is crucial to support both plants and pollinators.

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Effects of surrounding land-use on pollinator availability and flower visitation in semi-natural grasslands

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Many semi-natural grasslands are remnants of larger grazed areas, and are now surrounded by intensive agriculture. Since pollinators have been negatively impacted by intensification of agricultural management, habitat loss and fragmentation, this raises concerns about the persistence of plant species dependent on insect pollination for their reproduction. We surveyed pollinators and flower-visitation in 18 semi-natural grasslands in Sweden, situated along a gradient of proportion of arable crops in the landscape (1km radius), with a systematically varying composition in share of forest, semi-natural grasslands and leys. Preliminary results from 2 years of plant-insect observations show that responses to landscape composition differed among insect groups and among species within a group. We will present this in more detail on a poster during the conference. The effects of landscape context on plant reproduction will thus likely differ based on the identity of a plant's pollinators.

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Co-flowering community effects on pollination success and plant fitness in food-deceptive orchid species

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Interactions for pollinators among co-flowering species can modify plant reproduction and selection on floral traits yet studies at the community level are rare. Food-deceptive orchids provide suitable models to test for community effects as they often depend on rewarding co-flowering species to attract pollinators. Here,

we used two deceptive orchids to address the effects of the co-flowering community on pollination and plant fitness. We fitted hierarchical latent-variable joint models with relative pollination success and fruit set as response variables. Together with phenotypic traits we included the animal-pollinated co-flowering species as predictors by using a reduced-rank regression approach. We found that the animal-pollinated community affected pollination success and fruit set even when accounting for effects of non-animal pollinated species. Our work highlights the importance of a multispecies perspective to understanding the eco-evolutionary dynamics of floral communities.

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Floral allometry and its relationship with pollinators along an altitudinal gradient of the tropical Andes of Bolivia

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Flower traits have been shown to be related to breeding systems (outcrossing vs. selfing), pollinators and can vary along environmental gradients. Environmental variation along altitudinal gradients is commonly associated with changes in the diversity of plants and animals, making them ideal systems to study variation in flower traits and its relationship with pollinators. We measured flower traits of 20 plant species and observed their pollinators (flower visitors that touched reproductive parts of the flower) along an altitudinal gradient (1000-4500m) in the tropical Andes of Bolivia. Flower traits included flower size, entrance diameter, flower length and anther-stigma distance. In particular, we compared allometries of stigma-anther height along the gradient. In this study we test the hypothesis that anther-stigma correlations is stronger at higher altitudes, assuming that at higher altitudes the conditions are harder, pollination is less reliable and therefore selfing plants species would be more common. Additionally, we tested whether anther-stigma height correlations are related to more generalist plant species or a particular guild of pollinators.

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Variability in Dwarf shrub functional traits in response to experimental drought in coastal high-latitude heathlands

Akuonani Zakeyo Phiri, University of Bergen

Global climate change is altering ecosystems in high-latitude regions, causing extreme weather events such as heavy rainfall. This impacts vegetation growth and productivity, thus emphasizing the importance of understanding their ecological adaptation. Our study explores how coastal high-latitude heathland dwarf shrubs (Calluna vulgaris, Empetrum nigrum, Vaccinium vitis-idaea, and Vaccinium

myrtillus) respond to drought using Droughtnet shelters. We used 90% roof cover to simulate extreme drought and control without cover. We studied different growth stages (Pioneer and mature) in Lygra (south) and Tjøtta (north), areas with different bioclimates. We measured traits - plant height, specific leaf area, leaf thickness, and leaf dry matter content. Preliminary results show species-, stage-, and site-specific trait variations, revealing complex plant-climate interactions. This research is vital for gaining insights into the dwarf shrubs' resilience and adaptability.

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Warm or bright - using functional traits to explain microhabitat use in insect pollinator communities

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Environmental heterogeneity in forest understories creates microhabitat niches differing in light intensity and temperature. Do pollinators exploit these niches and, if so, how is this supported by their traits? In early spring, bumblebees forage on a sole floral species bilberry in heterogeneous hemi-boreal forests. We used these conditions to study species coexistence while excluding partitioning through exploitation of different floral resources. We combined full-day monitoring of bumblebee communities, trait measurements and joint species distribution modelling. We showed that temperature conditioned species occurrence – acting as a filter from the local species pool – while light intensity explained species abundance, with species partitioning along a light intensity gradient. These responses were supported by visual and thermoregulatory traits. This study extends upon previous findings of microhabitat partitioning as potential mechanisms underpinning bumblebee coexistence.

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Linking taxonomic and functional diversity: insights from the community dynamics of Finnish forests understorey

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Climate change, invasions and global biodiversity decline alter local community composition: over the last decades, this has led to variable species turnover in Finnish forest understorey.

To understand the dynamics of these communities, taxonomic and functional diversity are often used interchangeably, or positively correlated. However, whether these taxonomic changes actually translate into shifts in the functional community composition remains unclear.

By integrating three decades of understorey vegetation data across Finland and plant functional traits, we compare taxonomic and functional species turnover. We then partition functional species turnover to understand if shifts in functional diversity are driven by species loss, gain or persistence through abundance shifts.

This allows us to generate mechanistic insights into biodiversity change for better assessing it, and setting a foundation to link biodiversity changes to changes in ecosystem functioning.

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Trees for solitary bees - importance in space and time

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To understand and mitigate declines of bee populations, it is crucial to increase the knowledge on the habitat use of a diversity of bees. Herbaceous plants are often in focus as important foraging resources for bees while woody plants have received less attention despite constituting a large proportion of many bees' diets, especially during springtime. In our study, we investigate the importance of trees for solitary bee communities in grasslands embedded in agricultural landscapes, as well as the spatial scale of tree impact. In particular, we hypothesize that trees are most important in spring when many provide floral resources. We relate solitary bees, surveyed across the spring and summer season, to trees of different height categories, and we estimate the best spatial scale of tree impact, including a distance decay function. Our results will be important for the management of bee diversity in agricultural landscapes, and to promote pollination services by bees.

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Climatic drivers of senescence phenology in Arctic tundra plants

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Plant growing season phenology in Arctic regions is currently undergoing changes with advancing snowmelt timing leading to earlier spring green-up. Yet, there is

limited knowledge regarding drivers of end-of-season (EOS) phenology, even though EOS has important implications for both ecological processes and global climate.Autumn leaf senescence (marking EOS) was monitored in the field for common plant communities over an eight-week period at a high-Arctic site in Svalbard (78°10'N, 16°04'E) in July – September 2023. Plant phenology and climatic data was also recorded from spring – late autumn by automated monitoring stations equipped with timelapse cameras 'phenocams', and soil moisture and temperature sensors. Our presentation will show results on the interplay between plant senescence, soil moisture and temperature, and snowmelt timing, at species and community levels. These results will improve our understanding of potential climatic drivers of EOS in tundra plants communities.

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Beyond borders - Revealing range expansion dynamics through phenological insights

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Climate warming can lead lowland plants to expand beyond their current range limits, extending into the alpine ecosystem, and posing a risk for native species. During range expansions, new biotic interactions arise, which may impact the extant community. Such range shifts can be limited by seed production, dispersal, establishment, and plant growth. The RangeX project studies the role of warming and competitive interactions in limiting range-expanding species' colonization of alpine grassland, and the consequences for the ecosystem functions in these areas. A key aspect is investigating plant phenology, which reveals dynamic interactions between native and novel species. Examining the flowering start, duration, and peak, as well as the reproductive output of ten lowland plant species translocated to higher elevations provides insights for predicting and managing ecological impacts of range-expanding species.

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The roles of seasonality and management in shaping the interactions of honeybees with other taxa

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University of Helsinki and University of Jyväskylä, Finland and Norwegian University of Science and Technology, Norway/ Nerea Abrego, University of Helsinki and University of Jyväskylä, Finland/ Tomas Roslin, University of Helsinki, Finland and Swedish University of Agricultural Sciences, Sweden

The Eltonian niche, the set of interactions of a species with other taxa, varies in time and in space but also due to human management. To compare the impact of seasonality to that of management effects, we studied how the interactions of honeybees change. Based on DNA traces of interaction partners archived in honey, we can infer honeybee interactions with floral resources and microbes in their surroundings, their hives, and themselves. To compare the different effects shaping honeybee interactions, we used joint species distribution modeling. With the wide variation in the interactions of bees from different hives, regions, and beekeepers, the imprint of the season remained relatively small. During the summer, the different interaction partners changed substantially, but hive-and taxon-specific patterns were largely modified by hive management. Thus, the beekeeper and colony identity are as important determinants of the honeybee's realized Eltonian niche as is seasonality.

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Carry-over effect of artificial light at night on daytime mating activity in an ecologically important detritivore

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Artificial light at night (ALAN) is a growing environmental problem influencing the fitness of individuals through effects on their physiology and behaviour. Here, we investigated the impact of ALAN on the mating behaviour of an ecologically important freshwater amphipod, Gammarus pulex, during both days and nights. We manipulated the presence of ALAN and the intensity of male-male competition for access to females that influence mating activity. We found the impact of ALAN on mating activity to be stronger during the day than during the night. While ALAN only reduced the probability of precopula pair formation during nights, it both decreased general activity and increased the probability of pair separation after pair formation during the day. Thus, ALAN reduces mating success in G. pulex not only directly, through effects on mating behaviour during nights, but also indirectly through a carry-over effect on daytime activity and the ability to remain in precopula.

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How Introducing Flower Meadows Affect the Stability and Diversity of Plant-Bee Networks in Oslo City Center

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Urbanization poses a significant threat to global biodiversity, leading to higher rates of species extinctions due to large-scale landscape transformations. This phenomenon adversely impacts plants, pollinators, and their interactions. Our study aims to explore if pollinator conservation efforts in Norway, specifically habitat restoration, affect pollination networks. We focused on a newly established meadow in Oslo city center and its impact on the plant-bee interaction network in the surrounding urban landscape. We seek to examine whether the newly introduced meadow increases the stability of plant-bee networks by enhancing resilience to disturbances and promotes diversity in plant-bee interactions. To assess the resilience of the sampled plant-bee networks, we plan on simulating secondary extinction events of pollinators by systematically removing plants and observing the consequential loss of the pollinators that rely on them for floral resources.

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Interactions between benthic vegetation, drifting filamentous mats, and epifaunal communities in soft bottom shallow water habitats in the Baltic Sea.

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Benthic vegetation plays a crucial role in shaping epifaunal communities by providing habitat and food for numerous taxa. In the eutrophic Baltic Sea, fast-growing drifting algae and cyanobacteria can form extensive mats, which add to the factors that influence epifaunal communities. In this study, we assessed the influence of benthic vegetation, dominated by the angiosperms Stuckenia pectinata

and Myriophyllum, and filamentous mats on epifaunal communities in shallow soft bottoms in the Baltic Sea (Gotland, Sweden). We used Generalised Linear Mixed Models (GLM) to evaluate the importance of benthic vegetation vertical structure, vegetation species richness, angiosperm biomass, and biomass of filamentous mats on a) epifauna abundance and diversity and b) abundance and biomass of key herbivores in the system: the crustaceans Gammarus and Idotea, and the gastropods Theodoxus fluviatilis and Hydrobiidae. Overall, factors related to habitat-forming vegetation, such as vertical structure, species richness, and angiosperm biomass were significant predictors of epifauna abundance and the abundances of the crustacean and gastropod herbivores. Biomass of filamentous mats had a significant positive effect only on the gastropods. This study shows that, while drifting filamentous mats can drive high abundances of specific key taxa, supporting the overall epifaunal community requires the habitat provided by benthic vegetation species. As increasing temperatures and eutrophication favour the growth of filamentous mats, managing for the protection of diverse, abundant, and vertically complex benthic vegetation is key in supporting healthy coastal ecosystems. With this aim, we propose the use of vertical complexity as a tool to help characterising benthic vegetation.

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Spatial and temporal variations of insect herbivory in tundra ecosystems

Eleanor Greer, Agricultural University of Iceland/ Isabel C. Barrio, Agricultural University of Iceland

Insect herbivory currently occurs at low intensity across the tundra, but this intensity is predicted to increase as the tundra warms. To assess these trends over time, we recorded leaf damage by insect herbivores on Betula nana, a common tundra shrub, and related the findings to climate data. For seven years we have collected leaves from permanently marked plants in two field sites in the Icelandic highlands and recorded signs of leaf damage to assess temporal and spatial variations in insect herbivory. While the data shows considerable variation within and between sites and across years, we found that leaf damage generally increased under warmer conditions. Given the ubiquity of insect herbivory in the tundra, an increase in intensity could have major impacts on the make-up of plant communities and their associated food webs. Therefore, a protocol to accurately monitor insect herbivory is crucial for understanding biodiversity changes in these vulnerable ecosystems.

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Diving deep: Seabird foraging tactics and local prey field

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Foragers in patchy environments need to decide what patches to use and how to allocate their time between them. Optimal foraging theory describes these choices through the relationship between energy expenditure vs. gain. Very few studies testing this have had spatiotemporally overlapping data on both predator & prey movement. In this study an autonomous sail drone was operated in the Baltic Sea. It was combined with telemetric dive data of Common Guillemots from the same location to determine how prey distribution and abundance affects diving behaviour. Patch selection was investigated by comparing abundance vs. utilization of different patches, while GAMMs were used to predict dive behaviour. Increased understanding of these interactions can predict how Guillemots are likely to be affected by further change in prey populations. This is also a pioneering method that offers a time-and cost-effective method for obtaining data with high spatiotemporal resolution.

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Testing the consistency in Pinus spp. pollen's chemical response to UV-B radiation, using a greenhouse experiment.

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Some evidence indicates that the abundance of phenolic compounds found in pollen grain exines is affected by the exposure of UV-B radiation. If this response is consistent across and within populations, pollen grains may be used as a proxy to reconstruct past UV-B radiation. The aim of this project is to test the consistency in Pinus spp. pollen's chemical response to UV-B radiation. We have conducted a greenhouse experiment where pollen of Pinus sylvestris from Norway (300-340 m.s.l.) and Pinus uncinata from Spain (1600-2200 m.s.l.) were exposed to enhanced doses of UV-B radiation. Using FTIR data, we found weak evidence of a response in Pinus sylvestris, where pollen grains exposed to UV-B radiation had slightly higher abundance of phenolic compounds than the pollen grains in the control group. However, other potential factors may have caused variations in the chemical response (e.g., sampling time, location along the elevational gradient, variation between individuals).

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Functional traits of Epirrita autumnata (Autumn moth) across space and time: An entomologic collection-based study.

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Biological collections represent an immense source of information relating individuals from many different species to a point in space and time. This allows the study of how different species traits change in relation to local environmental conditions. Here we investigate how wing length, area, colour and symmetry vary over time and with climate. We focus on the well-known birch defoliator Epirrita autumnata (autumn moth), which occurs in cyclic outbreak events resulting in mass defoliation of birch forests in Norway, approximately every ten years. The samples used were collected in Norway and curated at the natural history collections at the NTNU University Museum. We photograph the specimens and use image analyses to measure functional traits. We test how the traits vary over time and with temperature and precipitation, and put the results in the context of changing climate. The patterns found may be used to predict species responses to different climate change scenarios.

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Combining citizen science data and systematic data to track Swedish biodiversity trends

Hedvig Nenzen, SLU

To improve ecological understanding and improve conservation planning, it is essential to know if species are changing their distributions. The first goal of this project is to provide species trends from both citizen science data and systematic monitoring data. Integrated Species Distribution Models (ISDMs) make it possible to extract the information contained in different data types while avoiding biased conclusions. I will present preliminary spatio-temporal trends of some species, and the full project will focus on plants, insects and birds. To correctly anticipate and mitigate biodiversity changes, we need to understand what causes the observed biodiversity changes. Models usually attribute species trends to environmental drivers, but I aim to include species interactions as a potential driver. I will infer species interactions from extinction cascades. Interactions inferred from the data will be validated with a database of interactions among 4125 Swedish species.

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The Nordic Borealization Network (NordBorN)

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The biome boundary between the boreal forest and tundra is rapidly shifting due to ongoing climate warming and changes in land use. As a result, many species typical of the forest are expanding into the tundra, a process known as borealization. These shifts in the forest-tundra biome boundary will have important consequences for the functioning of terrestrial Nordic ecosystems and ultimately, for their ability to provide valuable ecosystem services. The Nordic Borealization Network (NordBorN) is a five-year project funded by NordForsk that will establish a collaboration platform across the Nordic countries to understand the implications of borealization in Nordic terrestrial ecosystems. The aim of NordBorN is two-fold: 1) to create a venue for research excellence in terrestrial ecology to understand the processes, drivers and consequences of borealization of Nordic ecosystems, and 2) to establish a training hub for the next generation of Nordic researchers.

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Seeds on the move: hydrochory dynamics in the riparian zone of a free-flowing boreal river

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Changes in the flow regime due to regulation or a changing climate can significantly influence the dispersal of riparian plant species via water. We studied how hydrochory shaped riparian plant dispersal over time and space along Hjuksån, a free-flowing river in northern Sweden. Seed traps were placed one year before, and during the 2018 spring flood at two elevations in the riparian zones of lakes, slow-flowing, and rapid river sections. After seed identification, we ran a germination experiment to assess seed viability for the respective species. We found almost 90%

of the 18000 trapped seeds in the spring-flood-traps. More than half of them was on 40 cm elevation instead of at the water line, especially along rapids (64.5%) and slow-flowing reaches (73.4%). This pattern was less strong during the rest of the year, and indicates that these river sections may be especially sensitive to a changing flow regime.

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Microclimate, an inseparable part of ecology and biogeography

Julia Kemppinen, University of Oulu, Finland

Microclimate science has developed into a global discipline. Microclimate science is increasingly used to understand and mitigate climate and biodiversity shifts. Here, we provide an overview of the current status of microclimate ecology and biogeography, and where this field is heading next.

We identify major knowledge gaps that need to be filled for further advancing microclimate methods, investigations, and applications. These gaps include spatiotemporal scaling of microclimate data, mismatches between macroclimate and microclimate in predicting responses of organisms to climate change, and the need for more evidence on the outcomes of microclimate management.

This perspective paper brings together 97 experts and their views on the recent advancements and knowledge gaps in terrestrial microclimate.

75

More-than-human conflicts in urban allotment gardens

Karolina Lukasik, University of Helsinki

Though designed to promote human self-sufficiency and health, urban allotment gardens are also home to a multitude of plants, animals and fungi. They are, by necessity, multispecies spaces where interactions and conflicts between humans and others play out every day. My research focuses on the negotiations between the humans and the nonhumans regarding the use of garden space and time. These negotiations may take form of putting up barriers—and breaking them, or placing fake nests—and using them as food source. As a result, the garden landscape is changed and co-created by humans and other species. Using the data from two urban allotment gardens in the Finnish Capital Region and a combination of ethnographic and ecological methods, I propose a study of urban green spaces as co-created through a dynamic, more-than-human negotiation.

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The Humboldt Extension for Ecological Inventories: a standard facilitating FAIR ecology data

Yanina V. Sica, Yale University and Senckenberg Gesellschaft für Naturforschung/ Wesley M. Hochachka, Lab of Ornithology, Cornell University / Yi-Ming Gan, Royal Belgian Institute of Natural Sciences / Kate Ingenloff, Global Biodiversity Information Facility (GBIF) Secretariat / Dmitry Schigel, Global Biodiversity Information Facility (GBIF) Secretariat / Robert D. Stevenson, University of Massachusetts Boston / Steven J. Baskauf, Vanderbilt University Heard Libraries / Peter Brenton, Atlas of Living Australia, CSIRO / Anahita J.N. Kazem, German Centre for Integrative Biodiversity Research / John Wieczorek, VertNet

Complex ecological questions increase the need for collaboration across sectors, disciplines, and organizations and require enhanced access to and interoperability of ecological data at all spatio-temporal scales. The Darwin Core (DwC) standard (dwc.tdwg.org) has proven helpful in sharing species occurrence data and promoting biodiversity research following FAIR principles (findable, accessible, interoperable, and reusable). The DwC limitations to adequately represent ecological inventories in a structured manner have been overcome by the new Humboldt extension for ecological inventories (eco.tdwg.org). The solution presented by the ecological community provides means of recording information on sampling design, effort, scopes, and more details of the inventory process as structured metadata, and to represent abundance and absence data therefore enabling more powerful and realistic interpretation of the data beyond the original use cases, and across the studies and initiatives.

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Community-weighted decomposition with plant composition change over time

Katrín Björnsdóttir, University of Gothenburg / Haydn Thomas, University of Edinburgh / Isla Myers-Smith, University of British Columbia / Anne Bjorkman, University of Gothenburg / ITEX consortium

The impacts of warming on the tundra carbon balance is a critical unknown for predicting global climate change feedbacks. Plant litter represents the primary carbon input to tundra soils, yet it is unclear whether vegetation changes are altering litter decomposability. We combined datasets of 1) a multi-site litter decomposition experiment, 2) the largest database of tundra plant traits, and 3) three decades of vegetation monitoring from ~ 1,700 plots to quantify the change in decomposability of tundra plant communities over time. We found that litter decomposability increases with temperature and soil moisture over biogeographic gradients, but we found no significant change in decomposability over three decades of vegetation monitoring. Our results suggest that tundra vegetation change has so far had no net

impact on litter decomposability, but that in the long-term, if response follow space for time predictions, vegetation change could produce a positive feedback to climate change.

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Using data from satellites to study spruce performance after an extreme drought on different site conditions

Folarin Kazeem Olawale / Norwegian University of Life Sciences

Natural disturbances affecting forests globally have increased in both frequency and severity. One such natural disturbance is drought, which has been found to significantly impact the ecosystem. Past severe droughts in 2003 and 2006 reduced crop yields and increased tree deaths. However, many studies quantify 2018 drought as the most extreme and long-lasting dry period in central and northern Europe. In this study, the project aim is to understand how the severe drought of 2018 affected the productivity of spruce forests and how these forests recovered during subsequent years.

Remote sensing data from the NASA/USGS satellite will be utilize to determine the effect of drought. The Landsat mission, specifically data from Landsat 7 and 8, provides high-quality scenes capable of monitoring land changes by analyzing distinct spectral bands within the multispectral data. With this data, vegetation indices such as NDVI can be calculated using the Google Earth engine.

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EFForTS-ABM: Balancing economic benefits and ecological functions of agriculture in a former rainforest landscapes

Sebastian Fiedler, University of Göttingen, Germany /Julia Henzler, University of Göttingen, Germany/Suria Tarigan, IPB, Indonesia/Jann Lay, GiGA Hamburg & University of Göttingen, Germany/Kerstin Wiegand, University of Göttingen, Germany

Land-use change has transformed tropical forests into agricultural landscapes, notably rubber and oil palm plantations. While the agricultural systems offer economic benefits, they compromise ecological functions. We are interested in the potential for management to sustain economic gains and restore ecological functions. Given the complexity of the problem, fieldwork alone is insufficient, necessitating a modeling approach. We developed EFForTS-ABM, an integrated ecological-economic land-use change model using a combined agent- and grid-based approach. The model simulates the impact of smallholder farmers' land-use decisions on economic outcomes and ecological functions in oil palm and rubber plantations, based on field data from Sumatra, Indonesia. Here I present the model and exemplary scenarios affecting landscape composition and configuration, looking at resulting synergies and trade-offs at farm and landscape levels.

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Bridging ecology and youth research: a call for interdisciplinary collaboration

Konsta Happonen, Finnish Youth Research Society, Helsinki, Finland

This poster is an invitation to collaborate from youth researchers to ecologists. The young people of today and the future will bear the brunt of the ongoing biodiversity decline. We seek collaborations with ecologists based on three principles inspired by Soulé's tenets for Conservation biology: 1) the views of young people are important, 2) biodiversity has intrinsic value, and 3) the ecological basis of the welfare of future generations must be conserved. It is our belief that mixing ecological knowledge with knowledge about the values and wellbeing of people can result in research that contributes positively to the preservation of both ecosystems and the people who are part of them. The presenter is an ecologist by training and ready to mediate the languages of the two fields. We at the Finnish Youth Research Society can offer expertise in the methods of social sciences such as survey research. We welcome collaboration to integrate the perspectives of ecology and youth research.

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Herbivore diversity effects on Arctic tundra ecosystems - a systematic review

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Universitat Autònoma de Barcelona/ Tarmo VIRTANEN University of Helsinki/ David S HIK Simon Fraser University/ Elina KAARLEJÄRVI University of Helsinki/ James D M SPEED Norwegian University of Science and Technology/ Eeva M SOININEN UiT The Arctic University of Norway

Consequences of herbivore community changes in Arctic ecosystems is needed. Through a systematic review, we show that greater herbivore diversity led to increased abundance of herbivory marks and soil temperature, while reducing total abundance of graminoids and forbs, plant leaf size and height, moss depth, and litter abundance. Moreover, different herbivore functional groups had cumulative or compensatory effects, leading respectively to stronger or weaker responses than would be expected for each group separately. Current knowledge remains limited and geographically biased towards well-established research locations, with a strong focus on vertebrate herbivores' impact on vegetation. Future studies should address the role of herbivore diversity targeting a broader range of ecosystem responses and explicitly including invertebrate herbivores, to refine predictions on whether and where these shifts could mitigate or amplify the impact of environmental changes on Arctic ecosystems.

82

Biological diversity in the Norwegian basin: insights for the management of deep-sea mining

Laura Paiba-García, NTNU, Department of Biology / Geir Johnsen, NTNU, Department of Biology / Torkild Bakken, NTNU, Department of Natural History, NTNU University Museum

The ecosystem functioning in the Norwegian Sea is mediated by its biological diversity. To understand how anthropogenic impact, such as deep-sea mining, might be likely to impact it, it is necessary to account for all possible species records in the area. Species occurrence data was retrieved from the Ocean Biodiversity Information System (OBIS) and Global Biodiversity Information Facility (GBIF), for the sea surface, water column and seabed, from the 1900s to the present time. Occurrences without depth records were inferred using R, as it was expected that some records might lie in the deep-sea. Results elucidate the proportion of records in deep-sea areas constitute a small part of the overall data, and that sampling in those areas is required to build a more comprehensive understanding of the ocean environment. These results might also facilitate work for future studies on Marine Protected Areas in the shallower depths, looking for the best possible ocean management.

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A sedentary lifestyle facilitates studies of natural selection in wild populations of tortoise beetles

*Erica Winslott, Department of Biology, Lund University / Erik Wendel, Department of Biology, Lund University / Kristina Karlsson Green, Department of Plant Protection Biology, Swedish University of Agricultural Sciences / *Maja Tarka, Department of Biology, Lund University*
presenting author

Populations differ in their ability to adapt and evolve as a response to a changing environment. Understanding how and why these differences arise will be crucial for predicting their future. We use a novel study system for eco-evolutionary dynamics, the green tortoise beetle Cassida viridis, to understand how natural selection fluctuates between and within populations. By monitoring free ranging individual beetles in their natural habitat, we show that individuals are surprisingly sedentary, and this allows us to track them over their lives. This enables us to study how the environment, the host plant composition and phenotypic traits affect beetle survival. Our study provides valuable insights into the processes of natural selection and adaptive strategies, elucidating the microevolutionary dynamics in wild insect populations.

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Effects of cattle and cervids on small trees in spruce plantations in boreal production forest

Mélanie Spedener (Inland Norway University of Applied Sciences)/ Rémi Hérault (Inland Norway University of Applied Sciences) / Karen Marie Mathisen (Inland Norway University of Applied Sciences) / Gunnar Austrheim (Norwegian University of Science and Technology) / Morten Tofastrud (Inland Norway University of Applied Sciences) / Barbara Zimmermann (Inland Norway University of Applied Sciences)

Livestock grazing in forests has a long tradition in Norway and still is of importance today. There are contradictory conceptions of the compatibility of livestock grazing and timber production. Livestock might damage young trees by browsing and trampling. However, they also might have a “weeding effect” by removing competing vegetation. We studied the effects of cattle summer grazing on small trees in spruce plantations in southeastern Norway. We registered browsing damages on small trees of all species. Furthermore, we followed 700 small spruce trees for three years and monitored browsing and trampling damages, as well as their annual growth. In addition to cattle during summer, wild ungulates such as moose, red deer and roe deer life all year round in these forests. We included them in this study and compared the effect of cattle to the effect of these wild ungulates.

85

Figs and frugivores in the Afrotropics: inferring biotic interactions in a seed-dispersal meta-network

Kaare Sloth Christophersen1, Brody Sandel2, W. Daniel Kissling3, Kristian Trøjelsgaard1, and Michael Ørsted1 / 1 Department of Chemistry and Bioscience, Aalborg University, Aalborg, Denmark. 2 Department of Biology, Santa Clara University, Santa Clara, CA, USA. 3 Department Theoretical and Computational Ecology, University of Amsterdam, Amsterdam, The Netherlands.

Natural and anthropogenic climate change influence the geographical range and survival of species and can lead to new or lost species interactions, eventually re-organizing entire biological communities into new novel communities. However, species networks are inherently complex and difficult to fully characterize, thus we often have an incomplete picture of all potential interactions in a community. Machine learning has proven useful for inferring biotic interactions in ecological networks, thereby filling the gap of unobserved but potential interactions. Here we develop a macro-ecological framework for inferring seed-dispersal interactions. Specifically, we gathered data on mutualistic interactions between Afrotropical figs (Ficus) and frugivorous animals which consume figs, dispersing their seeds. Based on 734 studies, we compiled a database of 4570 unique empirical interactions between 106 fig species and 492 frugivore species (271 birds and 214 mammals). Here we show how these data are taxonomically and geographically biased toward highly studied families and geographic areas, highlighting the need for unbiased predictions of potential species interactions. We also elucidate how these observed interactions can be combined with functional traits of both the figs and frugivores in machine-learning algorithms for classifying novel interactions. By understanding how functional traits drive seed dispersal interactions on a macro-scale, it is possible to model lost or acquired interactions as well as extinction velocity and sensitivity as species move in response to global change. The proposed framework can ultimately provide new insights into the stability of ecological communities on a continental scale, and the importance of specific functional traits in seed dispersal networks.

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To reproduce, or not to reproduce, that is the question. Reproductive choices in reindeer facing high population density

Mikaela Tillman, Norsk Institutt for Naturforskning/Torkild Tveraa, Norsk Institutt for Naturforskning/ Sandra Hamel, Université Laval/Nigel Yoccoz, UiT Norges Arktiske Universitet/John-André Henden, Havforskningsinsituttet//Audun Stien, UiT Norges Arktiske Universitet

Food limitation may affect life-history strategies both directly, and indirectly via phenotypic traits. Understanding the pathways of how life-history strategies are

affected by environmental change is vital for understanding biological systems and making robust predictions. This study disentangles the direct and indirect effects of environmental variability on life-history strategies in an Arctic ungulate inhabiting a seasonal and variable environment.

We have developed a pathmodel for reindeer, mechanistically linking female body mass, reproduction, density dependence and environmental variability. The combination of long-term, seasonal data and a pathmodel provide new knowledge of the relative contribution of direct and indirect effects and a mechanistic insight to life-history strategies. We show how individuals facing high densities may adopt a conservative reproductive strategy, and how high densities impact reproduction both directly and indirectly, via female spring body mass.

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Unlocking ground-based imagery for habitat mapping

Naia Morueta-Holme, University of Copenhagen / Lars L. Iversen, McGill University / Derek Corcoran, Aarhus University / Carsten Rabhek, University of Copenhagen, Peking University & University of Southern Denmark / Signe Normand, Aarhus University

Fine-grained environmental data across large extents are needed to resolve the processes that impact species communities from local to global scales. Ground-based images (GBIs) represent an underused resource that can capture habitat complexity at biologically relevant resolutions. In this presentation, we explore promising approaches to habitat mapping through the integration of multimodal data and computer vision. We present empirical case studies of how GBIs such as Street View can be applied to predict the distribution of species at fine scales across large extents, and to automatic classification and quantification of habitat features. We finally discuss challenges and opportunities in using GBIs as a complement to existing remote sensing resources for ecology research and biodiversity monitoring.

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Emergence of the strategies of soil microbes through eco-evolutionary dynamics, insight from a trait-based model

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Soil microbes are important drivers of carbon and nutrient fluxes in terrestrial ecosystems through their strong contribution to organic matter decomposition and nutrient cycling. However, these ecological processes are supported by a large diversity of microbes with a wide range of life history traits. Recent metagenomic studies have shed light on the combination of traits that characterise microbial

communities depending on their environment, but species-level uncertainty remains. We propose a trait- and individual-based and spatially explicit model of microbial communities, including evolution, to explore the emergence of ecological strategies. In particular, we consider three main trade-offs linking traits: energetic expenditure of physiological processes, allocation of biomass in the cell and stoichiometry of cell components, which interact with environmental factors such as organic matter quality, availability, stoichiometry and stress.

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The Effects of Crop Residue Diets on Cricket Performance and Frass Fertilizer Potential

Sara Capitan, Sveriges Lantbruksuniversitet / Åsa Berggren, Sveriges Lantbruksuniversitet

To enhance the sustainability of cricket farming, this study investigated the potential of using crop residue (i.e., plant biomass leftover after harvest) as a sole diet for house crickets (Acheta domesticus). Crickets (n=600) were reared in controlled conditions in a 56-day feeding trial under a 12-h light regime. The experimental diets (n=3) consisted of dried crop residue from marrow pea, tomato, and a grain-based control diet. Water and feed were offered ad libitum, and survival and weight were recorded weekly. Frass was collected continuously and analyzed for nutrient composition. At day 56, the control diet had the highest survival (58.5%) and cricket biomass (6.61g). Tomato residue led to the lowest survival (36.5%) and biomass (1.6g), and pea residue had survival (54.5%) similar to the control but lower biomass (2.87g). This study highlights the feasibility of using crop by-products in cricket farming and the fertilizer potential of house cricket frass.

90

Advancing Genetic Monitoring: Discovery of SNPs in the Norwegian Red Deer (Cervus elaphus)

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Reliable information about population processes is crucial for successful management and conservation of natural populations. Genetic markers, e.g. SNPs, provide an important tool for monitoring. We developed 96 high quality SNP markers for individual identification of red deer (Cervus elaphus). We sequenced ten individuals sampled across Norway. We applied strict criteria to find high-quality

and highly informative SNPs and tested 309 SNPs on 94 individuals. The best performing 96 SNPs were selected for the final panel (2 Y, 4 X and 90 autosomal). While tissue samples performed best, scat samples also yielded reliable results. The panel was able to identify individuals with high confidence, and the autosomal markers were highly informative in population level analyses. The panel is a promising tool for acquiring information about population processes. SNP-based studies have the potential to increase knowledge about the population dynamics and improve current monitoring in red deer.

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A Blueprint for Sustainable Green Corridor: A Case Study Nyhavna in Trondheim

Federico Garcia Castro Department of Biology NTNU/Kamal H. Robin Department of Biology NTNU/Sanam Bybordi Department of Biology NTNU/Tor Henrik Ulsted Department of Biology NTNU/Thor Harald Ringsby Department of Biology NTNU/Gine Roll Skjærvø Department of Biology NTNU

Urban greening is widely based on conventional gardening, which might not comply with local ecology. Our urban greening approach deviates from traditional gardening, focusing on local ecology and habitats. We have developed a framework to enhance the ecological aspects of urban greening, considering species occurrence in local habitats and prioritizing them based on their ecological, environmental, and social values. Species are collected from international data infrastructures, and their compatibility is assessed based on trait data, CSR ecological strategy, and environmental factors like urban water and soil structure. The IPBES ecosystem service framework evaluates species passing these filters for their social aspect. Analysed in R and Google Earth Engine, this data-driven method results in a list of suitable species for urban greening. While field testing is pending, this approach offers a rational method for species selection, aiming to create more eco-friendly urban spaces.

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The Growth of Weeds in Newley Established Meadows and Their Contribution to Pollinating Insects in Urban Environments

Thea Sofie Dørdal Sandvik, Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, P.O. Box 5003, NO-1432 Ås, Norway /Siri Lie Olsen, Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, P.O. Box 5003, NO-1432 Ås, Norway. Norwegian Institute for Nature Research, Sognsveien 68, 0855 Oslo, Norway /Astrid Brekke Skrindo, Norwegian Institute for Nature Research, Sognsveien 68, 0855 Oslo, Norway

Populations of pollinating insects are declining globally, and increased urbanization and the loss of insect habitats are considered the main threats. The Porsgrunn

Pollinator Habitat Project is one of the research projects designed to contribute to the implementation of the National Pollinator Strategy in Norway. The project is situated in Eastern Norway and is centred around the development of three newly established flower meadows in urban parts of Porsgrunn municipality. Vegetation analyses were performed and pollinators visiting pre-chosen weed species were recorded to examine whether the meadows had developed towards the desired state and if weed species attract pollinating insects alongside the meadow species. All the meadows showed a development over time but had not yet reached the desired state. Pollinators did visit some of the flowering weeds, showing that these plants can contribute positively to pollinator habitats, even though they are primarily unwanted in meadows.

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Can malformations in Pinus spp. pollen grains provide a new proxy for UV-B radiation levels?

Tonje Sætre Olsen, Alistair William Robin Seddon, Florian Muthreich and Eline Stava Taule

UV-B radiation is a form of environmental stress that many organisms/ecosystems are exposed to. This can lead to an increase in malformations in plants or to a reduction in reproductive success. Plant exposure to UV-B radiation has likely varied in the past, particularly during major environmental crises. However, UV-B radiation currently has no established proxy to quantitatively reconstruct its levels in the past.

I present my master's project, where we are using a greenhouse experiment to regulate exposure to UV-B radiation on Pinus pollen cones and ask: Does UV-B radiation exposure during maturation in male Pinus spp. cones increase the malformation rate in pollen grains? For our analysis we will train a Machine Learning (ML) model to automatically identify and count different classes of malformed pollen grains. In this poster we will present the workflow we are using to apply machine learning classification and automation in an ecological setting.

Poster session 2

14th March 2024 - Day 2 / 16:30 (posters available all day) / AF-Borgen

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Causes of hatching failure in urban-rural comparison

Zsófia Tóth1, Joslyn Hays2, Ann-Kathrin Ziegler1, Susana Garcia Dominguez1, Caroline Isaksson1 / 1 Biology Dept, Lund University, Sweden 2 Univ. of Denver, USA

In recent decades, the populations of many wild bird species have declined dramatically worldwide. One of the main reasons for this is that the hatching failure rate increased slightly between 1940 and 2023. However, we do not know whether urbanisation and pollution can affect hatching failure. We therefore investigated whether hatching failure and the causes of hatching failure differ between urban and rural areas. We collected all unhatched eggs in Malmö (urban) and Skrylle (rural). We opened the eggs to determine the cause of hatching failure (abandonment, early embryo death, fertilisation failure). The hatching failure rate in Malmö was 11%, while in Skrylle it was only 3%. The main cause of hatching failure in the urban area was abandonment (50%), while in the rural area the causes were almost equal. Further studies are needed to understand the reasons for the differences in hatching failure between the habitats.

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Morphological and population genomic variation of the Arctic fox (Vulpes lagopus) in Iceland

Anna Bára Másdóttir (University of Iceland) / Snæbjörn Pálsson (University of Iceland) / Ester Rut Unnsteinsdóttir (The Icelandic Institute of Natural History) / Nicolas Lecomte (University of Moncton) / Bruce McAdam (The Icelandic Institute of Natural History).

The Arctic fox (Vulpes lagopus) is Iceland's sole indigenous terrestrial top predator, showing variation between regions with the proposed existence of two main ecotypes based on diet: coastal foxes, and inland foxes. This study will further estimate and quantify this variation by analysing mandible morphology, stable isotopes, and population genomics in three regions in Iceland. The Icelandic Institute of Natural History has a large collection of over 12.600 fox mandibles sampled throughout Iceland since 1979, which will be used to explore the spatio-temporal changes in phenotypic traits, dietary preferences as well as genetic structuring of the species. Preliminary findings from mandible morphometrics are aligning with ecotypic and dietary differences, where inland foxes have larger mandibles (Eastern Iceland), while shape analysis reveals distinctions in the shape of the mandibular ramus among coastal foxes found in Westfjords.

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Analysis of variation in mtDNA and W-chromosome in White-tailed eagles

Brynhildur Magnúsdóttir, University of Iceland/Charles C. R. Hansen, Novo Nordisk/Snæbjörn Pálsson, University of Iceland.

The white-tailed eagle (Haliaeetus albicilla) went through a severe population decline during the 19th and 20th century. In Iceland, the population was reduced from 120 pairs in 1870 to about 20 pairs in 1914 due to human persecution and stayed that way for more than 50 years mainly due to fox poisoning. Since 1970, the growth of the population has been slow. Previous analyses of mitochondrial DNA (mtDNA) revealed two distinct genetic lineages within Greenland, Iceland and Norway while autosomal analyses showed more of a geographical structure between countries, with genetic isolation of island populations from the mainland populations. In this study we revisit the mtDNA analyses, using a recent genome assembly and by including sequences from around year 1900 as well as analyzing the population structure of the W chromosome. As mtDNA and W are transmitted maternally without recombination to offspring, selection on W might shape the population structure in mtDNA.

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Unveiling the potential of nuclear markers for increased sensitivity in eDNA analysis

Erik Karlsson, Swedish University of Agricultural Sciences, Department of Aquatic Resources/Lilian Pukk, Estonian University of Life Sciences, Institute of Veterinary Medicine and Animal Sciences, Department of Aquaculture/Martin Ogonowski, Swedish University of Agricultural Sciences, Department of Aquatic Resources/Göran Sundblad, Swedish University of Agricultural Sciences, Department of Aquatic Resources/Josefin Sundin, Swedish University of Agricultural Sciences, Department of Aquatic Resources/Anti Vasemägi, Swedish University of Agricultural Sciences, Department of Aquatic Resources

Northern pike, Esox lucius, holds an important role in the food web as a top-predator in fresh waters across the northern hemisphere. Despite its ecological and socioeconomic significance, pike is often overlooked in monitoring and new monitoring methods are therefore needed. Environmental DNA (eDNA) has emerged as a potential alternative.

Increasing the sensitivity of eDNA surveys is essential to gain reliable detection and quantification. eDNA studies has primarily targeted mitochondrial markers but recently nuclear markers have been shown to potentially increase detection rates.

To assess nuclear markers ability to provide reliable detection and quantification for

pike we designed assays targeting pike nuclear DNA and evaluated the assays in comparison with previously validated mitochondrial assays. Our results show that nuclear assays can increase sensitivity of eDNA surveys. Here we will present the results from our study and their implications on surveying fish populations.

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Year-round eDNA-based biodiversity monitoring of extreme weather events and wastewater discharge in Danish streams

Nadieh de Jonge, Aalborg University, Denmark / Trine Buus Nicolajsen, NIRAS, Denmark / Per Gørtz, NIRAS, Denmark / Søren Bastholm Olesen, DMR, Denmark / Martin Hesselsøe, NIRAS, Denmark / Jeppe Lund Nielsen, Aalborg University, Denmark / Natascha Kock Larsen, Envafors, Denmark

Extreme weather driven by climate change has led to an increase in untreated wastewater discharge in freshwater streams from combined sewer overflow (CSO) events. Current stream water quality assessment is largely based on morphological identification, bound by seasonality, specific expertise and is challenged in monitoring CSOs. Stakeholders from industry, consultancy and academia collaborated to develop an eDNA-based model for sensitive year-round biodiversity monitoring in Danish streams. Results show that eDNA sampling of stream water is able to provide a clear picture of year-round seasonal trends and weather events in the studied streams. eDNA analysis also enabled the identification of indicator organisms that report on CSO effects, including microbes, microeukaryotes and invertebrates. We show clear examples of how an eDNA-based model can enhance our ability to understand, monitor and respond to environmental challenges arising from climate-induced extreme weather events.

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How properties of biocontrol systems for insect management predict resistance evolution

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Chemical pesticides have harmful effects on humans and ecosystems and are subject to resistance evolution. Microbial biopesticides containing living parasites are a valuable alternative, but some studies show that they can also lead to

resistance evolution. Theoretically, the risk of resistance evolution should relate to the biochemical complexity of interactions between pests and pathogens, but this theory has never been tested. We meta-analytically examined studies (Web of Science, 1990-2023) with data on insect susceptibility to biopesticides for several generations of evolution. We categorised biopesticides into three groups according to increasing presumed complexity in host-pathogen interactions: viruses, bacteria, and other agents (e.g., animals & fungi). We found the highest rate of resistance for viruses, followed by bacteria. We suggest that simple biopesticides are most at risk of resistance evolution, and most need resistance mitigation strategies.

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Thermal plasticity across latitude: connecting gene expression and the phenotype in a temperate butterfly

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Temperature is one of the most important abiotic factors affecting life, and it is rising rapidly due to climate change. Local adaptation and phenotypic plasticity interact to help species cope with such changes but much about these interactions is still unknown, especially at intraspecific levels. We use RNAseq on Glanville fritillary larvae from Finland and Spain, reared at two temperatures, to test how latitude, temperature and their interaction affect gene expression. We do enrichment analysis to determine the function of differentially expressed genes and relate our results to phenotypic findings. We found the most differentially expressed genes in response to temperature, and gene expression profiles reacted to the interaction between temperature and population. Less genes were differentially expressed for population. Our results will shed light on the transcriptomic processes behind thermal plasticity, which will aid in better predicting species' responses to climate change.

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A strong decline of the endangered Apollo butterfly over 20 years in the archipelago of southern Finland

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Our paper examines the decline of the Apollo butterfly population in southern Finland over the past 20 years. We found that the population has declined significantly but the reasons are unknown. The decline could be due to habitat loss and fragmentation, climate change, and pesticide use as for many grassland butterfly species in Europe. The Apollo butterfly is particularly vulnerable to habitat loss due to its specialized habitat requirements. We note that the decline of the Apollo butterfly is indicative of a larger trend of insect population declines worldwide, which has significant implications for ecosystem functioning and human well-being. Our paper highlights the urgent need for action to protect insect populations and their habitats, including habitat restoration and increased public awareness of the importance of insects.

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The influence of riparian tree composition on stream macroinvertebrate communities and food webs in the boreal landscape

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Headwater streams are tightly linked to surrounding terrestrial ecosystems. Importantly, riparian vegetation influences the basis of stream food webs by supplying litter and controlling algal growth through shading. Yet, coniferous and deciduous trees differ substantially in the quality and quantity of litter they supply as well as in their shading regimes. This project aims to test how the composition of riparian trees affects stream macroinvertebrate community composition and food webs in small boreal streams. Stream reaches with different riparian tree composition were sampled for benthic macroinvertebrate diversity, biomass, and food web structure using isotopes and other biological markers. Governmental institutions in Sweden already recommend promoting deciduous cover in riparian zones to improve stream ecosystem functioning and productivity, but actual effects are not well documented. Thus, this study has the potential to inform current and future management practices.

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A near infrared spectroscopy model to estimate faecal nutrient content of Icelandic tundra herbivores

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Herbivores affect tundra nutrient budgets through dung deposition. Estimating nutrient concentration of animal dung with traditional wet-chemistry lab methods is expensive and destructive. Using near infrared spectroscopy (NIRS), a promising low-cost alternative, we develop the first general model for predicting faecal carbon, nitrogen and phosphorus concentration for vertebrate herbivores in the Icelandic Tundra. We collected 200 samples from three common herbivore species (sheep, reindeer, and pink footed goose) over an entire growing season. We first calibrate a model for each species which we then compare to a general model combining all species. NIRS based models will allow processing larger numbers of samples to answer fundamental ecological questions related to herbivore diet and phenological changes in diet quality, but also evaluate the contribution of herbivores to nutrient dynamics in tundra. Our model will be extended to other herbivores across the Arctic.

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Spectral Mating Preferences in Damselfly Species with Potential Evolutionary Implications

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Odonates have exceptional visual capabilities, including high-speed vision, a handful of spectral bands with polarization features, and the highest spatial resolution among insects. Thus, they are well-equipped to identify potential mates or competitors based on visual information, including soap bubble-colored Wing Interference Patterns (WIPs). Whereas vision bands are fixed in the electromagnetic spectrum by the molecular absorption of their corresponding rhodopsins, the wing interference fringes and their perceived chromaticity displaces according to wing

membrane thickness. Mode-locking is the interplay between energy transitions in molecules and interference from physical structures. If female mate preferences favor males with specific chromaticity, and wing thickness varies with wing size, sexual selection could potentially constrain or accelerate the evolution of wing size. Does the wing thickness co-vary significantly with the wing area within two Odonate species?

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Bootstrapping the Process of Training Ecosystem-Specific Animal Classifiers

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Our work demonstrates the promise of transferring machine-learnable knowledge between visually similar species from geographically distant ecosystems for ecological computer-vision applications. The main aims are (i) to boost efficiency during the training process of wildlife classification tools by removing the need for additional time-consuming and labour-intensive data collection, as well as (ii) to enable such models to achieve higher accuracies for classes that would otherwise be frequently misidentified due to the sparse associated training dataset. This is particularly relevant for the automated monitoring of rare or endangered species using camera-trap data. We achieve our goal by bolstering the training set for a given target species by adding selected supplementary images of a geographically distant proxy species. Our approach is tested in zero-shot learning scenarios for various example species pairs to allow for a comparison of accuracies and an analysis of the limitations.

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Spatial variation in life-stage-specific density regulation in a bird meta-population

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Density affects individual vital rates and drives populations' recovery rate after perturbation. Local differences in density regulation may affect patterns of extinction and influence meta-population persistence. Furthermore, spatial variation in density regulation may cause spatially explicit life-stage responses to density. We studied density regulation using individual-level data across life stages in a house sparrow meta-population. Density regulation on adult survival was

stronger in populations with unpredictable winter resources. In contrast, density regulation on recruitment did not differ among populations and acted through juvenile survival rather than fecundity. We show that estimating density regulation using individual vital rates rather than changes in density, demographic stochasticity and individual-level variation can be accounted for. With increasing habitat loss, it is important to identify heterogeneity in density regulation to predict population persistence.

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Navigating change: Fish ecological dynamics and phenotypic response

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Worldwide environmental change is ongoing. In our study, we assess the effect of environmental and biotic variables on co-occurrence patterns and on weight per individual in two sister species, the common bream and the white bream. Moreover, the temporal trend of several variables is analysed over the last 50 years. We find out that the abundance of potential competitors (perch and roach) and predators (pike), together with lowered visibility, reduce the co-occurrence chances between the common bream and the white bream. The difference in weight is significantly affected only by the proportion of pike, which drives an increased similarity in size between the two species. The temporal trend shows, among others, a significant decrease in water clarity. Overall, these results show the importance of a structured ecological community. The ongoing change in several environmental and biotic variables should raise a concern about the survival of the most vulnerable freshwater fish species.

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Water income and water loss – a study of the water economy of Betula nana in a drier climate

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We studied the effects of humid or dry air combined with high and low soil water availability in a factorial controlled conditions experiment with Betula nana. The results showed that the closing of stomata due to drier air prevented the expected increase in water loss from plants with low water availability, whereas plants with

good access to water had an increased water loss. This is an example of physiological acclimation to varying soil and air water content. In addition, the leaves that were produced during the experiment showed signs of morphological modifications, as the leaf size was reduced in plants with low soil water access. Adaptations for adjusting the stomatal conductance and leaf area according to the conditions contribute to plant survival in a changing climate.

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How does background design influence species distribu4on models under climate change scenarios?

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Macroecology studies large-scale biodiversity patterns and processes. However, process-based methods to explain broad biogeographical patterns are largely missing. Processes like consumer-resource dynamics, dispersal rates, and density-independent climatic effects influence trophic communities, ecosystem functioning and, ultimately, the global distribution of species. Here, we present a metacommunity framework that integrates density-dependent biotic interactions, group-specific dispersal functions, and environmental heterogeneity to generate predictions for species distributions, community dynamics, and ecosystem functioning. Particularly, we aim to understand the influence of biotic interactions in shaping higher-level community characteristics. The comprehensiveness of our approach will allow us to address questions as broad as the forecast of community transitions under climate change or the evaluation of priority conservation areas. By prioritizing a process-driven approach, our model offers a comprehensive understanding of macroecological theories and aids in defining large-scale biodiversity patterns.

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Development of state-and-transition successional models for woodland restoration

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Ecological restoration has become an important part of global initiatives due to its co-benefits for biodiversity conservation, climate change mitigation and reversal of land degradation. BirkiVist is a trans-disciplinary project aimed to scale up restoration of native birch woodlands in Iceland. Among tools developed in the project are state-and-transition models (STMs), often used to synthesize and

communicate information about alterative ecosystem states and transitions between them. In restoration, STMs describe different stages in ecosystem trajectories from degraded land towards reference ecosystems or reference models, potential deviations from them, and interventions for realignment if needed. Our STMs are based on published and unpublished studies on patterns and processes of assisted and natural succession of birch woodlands along with expert panel inputs. They will in future aid in planning, implementation, evaluation, and adaptive management of restoration projects.

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Large scale autonomous data sampling for spatiotemporal fish distribution estimates

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Monitoring fish distribution continuously in a large area over longer time periods have previously been next to impossible due to high costs (vessels, equipment and staff). Autonomous data collection with Unmannes Surface Vehicles could create possibilities to perform long-term sampling over large areas, by being cost efficient, safe and environmentally friendly. Being new technology, it is however unclear whether the results are reliant and accurate, and comparable to more "traditional" sampling methods in quality. To investigate its utility, we analyse data from five time-periods of saildrone fieldwork. We describe how we used an autonomous sail drone equipped with, amongst other scientific sensors, an echo sounder, to describe and map the distribution of small pelagic fish over four months across five years in the area between Öland and Gotland, which is an important feeding ground for marine top predators in the Baltic Sea.

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Glow-worm reproduction under light pollution: female behavioural adaptation to artificial light

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Artificial light at night (ALAN) threatens nocturnal organisms by transforming natural patterns of light and dark that have previously remained constant over species' evolutionary history. ALAN interferes with reproduction in the common glow-worm, a beetle with bioluminescent females that glow in the night to attract flying males, by decreasing mate attraction success and inhibiting signaling. We investigated the ability of female glow-worms to adapt to artificial light using experimental arenas illuminated at one end and dark at the other. We placed females in the lit end of the arenas and monitored their glowing and movement over two nights. Preliminary

results indicate that female glow-worms lack adaptive responses to artificial light, failing to move away from the light or increase their glowing under it. The results highlight the vulnerability of glow-worms to ALAN, and the difficulty species can face dealing with light pollution due to lack of adaptive responses.

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Using CORINE Land Cover and GBIF records to untangle biodiversity responses to land-use changes

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Land-Use Land Cover (LULC) changes are a major threat to biodiversity and linked to shifts in assemblages and community homogenisation. To understand the links between increasing demands for resources and biodiversity loss, we used CORINE Land Cover to map and quantify land cover changes across Norway between 2000 and 2018. We then mapped GBIF occurrence records onto the LULC transitions and estimated temporal turnover of assemblages. The largest LULC changes detected by CORINE are forestry, urbanisation, and agricultural intensification. Our study suggests that despite the high number of GBIF records available, their spatial overlap with CORINE-detected LULC changes is limited. We also found that rates of temporal turnover of assemblages tend to vary by the land cover transition type, year of recording and taxonomic group. Our study identifies key ecosystem changes and highlights the need for targeted biodiversity monitoring and accounting for impacts of future LULCs on biodiversity.

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Climate Warming and Aquatic Food Web Efficiency

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Climate warming may affect the efficiency by which energy reaches top trophic levels (food web efficiency, FWE) and thereby biomass distributions in aquatic systems. This has implications for fishable biomass and ecosystem functioning, yet how warming affects aquatic FWE is unknown. We adopt a space-for-time approach to resolve how warming affects FWE by utilising a large dataset encompassing temperate and boreal lakes. This data includes abiotic information, species and biomass data on phytoplankton, zooplankton and fish. We hypothesize that (i) warming decreases FWE and consequently biomass at top relative to bottom trophic levels, and (ii) the response depends on lake characteristics, nutrient and light limitation. We show how these factors can mediate temperature effects on FWE and how shifts in plankton species composition can play an important role. Our results contribute to new understanding about how, when and where global climate warming may limit aquatic biomass production.

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Wildlife's fast food: Human refuse and intraguild dynamics

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Generalist species often thrive in disturbed landscapes exploiting human refuse. Theory suggests that human disturbance and the proliferation human-tolerant species can destabilise ecological communities. However, empirical assessments seldom address generalists and their use of human refuse, often missed by diet analysis methods. We analysed faecal samples from two generalist predators, red fox and pine marten, through DNA-metabarcoding to study their relative use of wild prey and human refuse in an area that sees intense ungulate management and recreational activities. Both predators fed largely on wild prey. However, during wild prey scarcity, foxes relied heavily on human refuse, ungulate carrion and dog faeces. Human refuse enables distinct foraging strategies, potentially enabling coexistence at higher densities, impacting prey. Dog faeces may pose health risks to wildlife and humans, yet if faeces consumption is widespread, it may reshape our understanding of trophic networks.

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Temperature increases the versatility of belowground plant-microbiota interactions in cold climates

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The ongoing change in climate extensively alters belowground interactions between plants and microbiota. Alterations in plant-microbiota interactions have significant implications for the functioning of ecosystems. To predict ecosystem change and protect vulnerable systems, it is therefore crucial to understand how climate shapes belowground plant-microbiota interactions. We test how prokaryote and fungal rhizosphere and root-associated communities of the perennial grass Festuca rubra are affected by temperature and precipitation in cold climate settings. We found that microbial communities were strongly shaped by temperature and to a lesser extent by precipitation. Temperature decreased relative habitat specialisation of the rhizosphere community and the fungal root-associated community. These findings indicate that with a rise in temperature in cold environments, plant-microbiota interactions become more versatile and adapted to a broader range of environmental conditions.

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Harder-working birds have a higher metabolism but do not perform better

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Birds can adjust their metabolic machinery to match energy demand. This is well documented in in birds preparing for migration or winter. However, it has yet to be tested if free-living breeding birds can increase their aerobic capacity in response to an increase in reproductive effort. We manipulated reproductive effort in wild blue tits in southern Sweden by giving them either extra or fewer nestlings. We then captured the male parent of each brood and measured the resting metabolic rate (RMR), maximum exercise metabolic rate (MMR) and endurance. We found that parents of enlarged broods had a higher RMR, but did not perform better or exercise for longer than parents of control or reduced broods. The number and quality of

offspring produced in each breeding season is a result of the amount of food delivered per nestling by parents and is therefore directly related to fitness. We demonstrate that some fitness-related metabolic traits may be more flexible than others in breeding birds.

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Some like it buffered: the response of vascular plants and bryophytes to forest microclimate

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Understory species experience buffered (less extreme) or amplified (more extreme) microclimate temperature relative to macroclimate. We investigated species responses to this buffering or amplification effect, focusing on vascular plants and bryophytes in 157 plots in three temperate forests. Species were classified into groups of forest affinity: core specialists, edge specialists, and generalists. We fitted generalized linear mixed-effects models, by species and by forest affinity, to obtain logistic response curves of the probability of occurrence against microclimate buffering capacity. For vascular plants, we found a shift in microclimate preference from buffering to amplification depending on forest affinity, while most bryophytes showed a preference for buffered habitats. The investigation of species responses to microclimate processes can improve our understanding of the thermal tolerance of forest biodiversity and help us anticipate its redistribution under climate change.

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Mountain birch functional trait responses to warming, soil origin and a neighbour.

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Advancing treeline in sub-arctic mountains can be linked to the continuously warming climate. How tree seedling performance is directly influenced by temperatures versus mediated by temperature driven changes in plant and soil properties, remains unclear.

Using a growth chamber experiment, we tested how Mountain birch seedling (Betula pubescens subsp. czerepanovii) functional traits respond to direct and interactive effects of temperature, soil origin, and presence of the neighbouring species, Crowberry (Empetrum nigrum).

Growth-related traits were generally more acquisitive at warmer temperatures while seedlings were less nitrogen-limited and exhibited a lower photosynthetic rate in soils from a warmer climate, and we found no interactive effects among the treatments. Hence, while increased temperatures directly contribute to tree seedling establishment, the long-term effect of warming may cause soil-mediated effects that influence important physiological functions in Mountain birch.

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Effects of Wintertime Hydropeaking on Riparian Zones

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Hydropower generates a substantial portion of Sweden's electricity, yet the effects of hydropeaking (rapid fluctuations in water release) on the ecology of riparian zones are poorly known. Hydropeaking is expected to have both direct effects, via alternate wetting and drying of the substrate, but also indirect ones, by affecting physical processes such as erosion, sedimentation and ice dynamics. This project aims to understand how hydropeaking and ice conditions interact and affect the riparian zone; specifically, erosion, sedimentation, vegetation and decomposition. To this end 30 study sites, spread out across streams in boreal Sweden, were used, spanning a latitudinal gradient of approximately 580 km, as well as including both inland and coastal areas. The study is ongoing, but we will present and discuss variation in stream hydropeaking intensity and size, decomposition and plant species composition in relation to hydropeaking.

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Reversal learning and colour preference in the Great Tit (Parus major)

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Cognitive flexibility, often tested by the reversal learning test, may be an adaptation to cope with changing (e.g. anthropogenic) environment. We tested reversal learning of 17 urban great tits (Parus major) that had to choose between two

locations marked with different colours and shapes, one with and one without food reward. Once they learned which side was rewarding, the reward's location was reversed, which was repeated several times over the course of the test. Initially, most birds first approached the side marked with yellow, indicating a colour preference, but after the first reversal, they visited the unrewarding location fewer times when the food was on the side marked with blue. After multiple reversals, the birds checked the previously unrewarding location faster and visited the previously rewarding location fewer times compared to the first reversal. This suggests they possess the ability to understand reversal, making them well-suited to adapt to anthropogenic habitats.

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Meiofauna's battle for significance in marine biogeochemistry

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Previous research has recognized the major role of bacteria and macrofauna in sustaining benthic ecosystem functioning. Yet, only a few studies have shed light on the hitherto neglected importance of meiofauna (invertebrates < 1 mm) for sediment biogeochemistry. Our results from two studies provide valuable insights into the importance of meiofauna respiration to sediment oxygen cycling. We obtained such results by first adapting a method for single-microscopic animal respiration and then we were able measure that meiofauna's respiration contributes 3–33 % to total sediment oxygen uptake in coastal systems. We also discuss which meiofauna are the most important players, how they react to low oxygen conditions (hypoxia) which ae now expanding globally and finally we discuss the outlook in the changing oceans.

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Large herbivores influence intraspecific variation in plant traits

Femke Pijcke

Plant traits are often used as an indicator of ecosystem functioning and how it is influenced by changing environmental drivers. Herbivores are one of the drivers which could impact plant traits, directly by the damage they inflict on plants and indirectly by changing the environmental conditions. In this study, we aimed to investigate the impact of large herbivore grazing on key leaf traits related to the

resource economics spectrum of arctic plants. Specifically, we focused on leaf phosphorus (P), nitrogen (N) and carbon (C) content and specific leaf area (SLA). Further, we assessed if the variation in plant nutrient concentrations found between grazing treatments surpasses the within species and site variation. The most general effect of herbivores was found on leaf P content; however, the direction of change was site specific. Our results further show that large herbivores also do impact plants N content and SLA, but these effects tended to be site and species specific.

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Impacts of reduced ice cover: Changes in lake biological communities over 30 years in an oligotrophic lake

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Due to warming temperatures, high-latitude lakes experience a loss of ice cover, resulting in earlier and prolonged ice-free seasons. This trend is expected to accelerate further and can have cascading effects on the entire lake ecosystem. We analysed ice phenology and changes in phytoplankton, zooplankton, and fish communities between 1989 and 2022 in an oligotrophic subalpine lake in Norway with low anthropogenic pressure to investigate the impact of climate change on lake ecosystem. Lacustrine communities changed during the study period. Phytoplankton biovolume and zooplankton density increased through time, the catch per unit effort of brown trout increased, while that of arctic char declined. The composition of the communities changed in parallel with increasing length of the ice-free season and changes in water physico-chemistry. These findings indicate that warming has pervasive ecological effects even in oligotrophic lakes with otherwise low levels of anthropogenic pressures.

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Heating the heath: How 23 years of experimental warming changes the biodiversity of an alpine hotspot

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Elevated temperatures because of global climate change are especially pronounced in high latitudes and elevations, where species are adapted to short and cold growth seasons. Since 2000, a Dryas octopetala heath on Mt. Sanddalsnuten in Finse, Norway, has been studied as part of the International Tundra Experiment (ITEX). Using open top chambers, the diverse plant community has been exposed to experimental warming (+1,5 °C). There is a lower cover and richness of bryophytes and lichens in experimentally warmed plots, as well as

higher litter cover and taller vegetation. Species compositions is also different, with higher soil moisture content in the controls as a possible explanation. After 23 years, the effect of warming has grown more pronounced than in previous studies. Our findings show the importance of long-term monitoring in studying slowly changing ecosystems. Further analysis will be presented in a master thesis in spring 2024.

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Seasonal vertical migration and lipid storage in marine high-latitude copepods (Calanus spp.) from West Greenland

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Calanoid copepods in high-latitude marine food webs act as an energetic link between primary producers and higher trophic levels. Investigating energy storage and diapause is important for understanding responses to environmental change. In Disko Bay, a changing marine ecosystem, we studied three co-occurring species during the summer-to-autumn transition (September-November) in 2023. Weekly sampling at 50m depth intervals was conducted to study the depth- and stage-specific abundances of Calanus hyperboreus, C.glacialis, and C.finmarchicus. We predicted state-dependent descents to diapause, with those holding larger lipid reserves migrating earlier. We estimated lipid reserves by measuring oil sac size of individual copepods. Preliminary results indicated that, at the study's onset, most individuals were already below 150m. The depth distributions, coupled with the lipid content findings, provide valuable insights into adaptations to seasonality and resilience to environmental change.

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How to navigate a time machine? - Unraveling the impact of relocation error when resurveying historical vegetation plots

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Investigating temporal vegetation change, by resurveying historical vegetation plots,

has been done more and more frequently in recent years. However, since most historical plots were not

permanently marked, their exact locations are uncertain. Studies addressing the errors associated with relocation are uncommon, nevertheless, they are crucial for interpreting the results. As part of a large resurvey of mid-20th century vegetation plots in West Greenland, we investigated how relocation error may impact studies of temporal vegetation change. We used information on slope, aspect, and altitude from the original survey to relocate 93 historical vegetation plots. When available, we supplemented with photos, maps, and plot descriptions. For a subset of 33 plots, we additionally surveyed between1-4 plots (sensitivity plots), to estimate the relocation error and assess the robustness of the resurvey method.

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Thermal fertility sensitivity and their consequences in butterflies

Isabel Resende (Stockholm University) / Christer Wiklund (Stockholm University) / Carl Gotthard (Stockholm University) / Constanti Stefanescu (Natural Sciences Museum of Granollers) / Rhonda Snook (Stockholm University)

Climate change increases the frequency of extreme weather events (e.g. heat waves), that brings consequences for species. Reproduction may be more thermally sensitive than more typically assessed responses, such as survival. Moreover, the potential for local adaptation of fertility in response to extreme temperatures, which could help mitigate consequences, is understudied. Here we present data on the thermal sensitivity of fertility in multiple populations of Pieris napi reared at benign and thermally stressful temperatures throughout development. We show that mating behavior of both males and females is altered under high temperature and that males lose fertility when reared at high temperatures. Loss of fertility is related to changes in sperm production and both Swedish and Spanish populations responded similarly. Future work will aim to link laboratory-based data with field and long-term monitoring data to better understand the future climate impacts on butterfly species.

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Clear local adaptation in butterfly photoperiodism but not thermal performance along a latitudinal cline

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In seasonal environments, insects synchronize life cycles to favorable conditions using cues like photoperiod and temperature. Geographic variation in both cues necessitates local adaptation in traits that regulate phenological responses, but these have been rarely studied across the same set of populations simultaneously. While photoperiodism clines are well known, thermal performance studies are inconclusive and often overlook non-linear responses. Here, we estimated photoperiodic diapause induction and non-linear thermal performance curves for development and growth across a 752 km latitudinal cline in four Swedish butterfly populations. Photoperiodism follows geographic patterns, inducing diapause at longer daylengths in the north, but thermal performance differences were small without clear clinal patterns. We conclude that photoperiodic responses evolve more readily than thermal responses, emphasizing photoperiodism as the key driver of local life cycle synchronization.

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How do reindeer affect phosphorus availability on the Scandinavian Mountains ?

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Herbivores also drive soil biogeochemical processes via vegetation shifts and by adding nutrients in the form of droppings and urine. Reindeer is one of the major large herbivores in the Scandinavian mountains.

While it has previously been observed that this large herbivore impacts nitrogen (N) availably, reindeer-driven mechanisms that can shift these ecosystems towards a more phosphorus (P) limited state, especially on forb-dominated areas, are much less explored. However, this shift can have a significant impact on P availability for soil microbes and plants. The overall objective for this study will be to investigate mechanisms by which reindeer grazing affects the availability and sorption of P in the soil, and how this compares to the availability of N.

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Reindeer grazing impedes expansion of birch dominated treelines in Northern Scandinavia

Hagenberg LWC / Pijcke F / Horstkotte T / Olofsson J / Siewert M

Climate change is expected to lead to treeline expansion, but herbivory may offset this. We quantify the effects of reindeer grazing on birch recruitment and growth in

the treeline ecotone in the Scandinavian sub-arctic. We conducted fieldwork along the border fence separating Kilpisjärvi in northern Finland (20 yrs of intensive year-round grazing), of Storfjord in northern Norway (autumn grazing). We measured seedling density and the allometry of trees, vegetation composition, nutrient loading of soils and its effects on adult tree growth rate along 20 transects. Preliminary results show that birch trees are kept in a grazing trap in the more heavily grazed area. High grazing pressure is also apparent from the reduced numbers of tree basal shoots and a general lack of leaves below reindeer browsing height (2 m). Additionally, we found a shift in field layer vegetation composition related to dung counts. Results on chemical composition and dendrochronology are still pending.

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Reindeer grazing changes horizontal and vertical root trait distribution in boreal pine forests

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In northern ecosystems, large herbivores shape ecosystem processes and carbon dynamics. Little is known about the horizontal and vertical response to grazing belowground. Here, we compared horizontal and vertical distribution of roots, community root traits, and soil microclimatic conditions between <50-year reindeer exclusions and neighboring grazed sites in pine forests in northern Finland.

Reindeer grazing reduced fine root biomass, but the effect was strongest in the topsoil and diminished with soil depth. While root biomass remained constant horizontally, root community traits did not. Further away from the tree, soil explorative traits were generally lower. Reindeer grazing led to an even stronger decline with tree distance. This coincided with less shrub cover in the open under reindeer grazing. Moreover, reindeer grazing, and tree distance affected soil microclimatic conditions. Overall, our study alludes to spatially heterogeneous effects of reindeer grazing belowground.

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Seasonal dynamics of alpine cryptogam microbiomes

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Alpine ecosystems are known for their harsh environmental conditions creating unique ecosystems dominated by bryophytes and lichens, collectively known as cryptogams. Cryptogamic species are crucial components of important ecosystem services and harbour diverse microbial communities that play critical roles in nutrient acquisition, including nitrogen fixation. Together, the cryptogam host and its associated microbial community form a complex and dynamic relationship that supports the functioning of alpine ecosystems. However, the environmental drivers of cryptogam-associated microbial communities remain poorly understood. This is particularly relevant in alpine ecosystems, where seasonal changes are highly pronounced. Using high-throughput DNA sequencing, we investigate the microbial communities associated with alpine cryptogams, how they very inter- and intraspecifically, in addition to the effect of environmental seasonality on cryptogam microbial community composition and structure

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Effects of climate change on herbivory in macroalgae: a laboratory experiment.

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Two-species interactions can be complex even in stable environments and further complexity is added with anthropic interferences. Aiming to predict climate change impacts on these interactions, we zoom in on how temperature changes affect the growth of coastal marine macroalgae as well as the activity of their grazers. We performed a lab experiment of the interactions between the fucoid Ascophyllum nodosum and the intertidal gastropod Littorina obtusata. Three temperatures (10 °C -in situ temperature when collected-, 16, and 19 °C) were used. We differentiated grazing on thallus versus receptacles and expected higher grazing pressure with increasing temperatures. After a three-week study, growth of the macroalgae was modest and similar across all temperatures, whereas area grazed differed, but unexpectedly mostly so for thallus and the coldest category. Grazing on receptacles did not differ between temperatures. Our results are an example of what could happen during heatwave periods.

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Do Ghosts of the past determine vegetation changes? Experimental evidenence from a 25yr long experiment

Judith Sarneel, Umeå University

Events that happened in the past can shape plant communities or plant soil feed backs. Such a legacy effect can change the resilience and resistance of vegetation to new disturbances or result in alternative stable states. Between 1995-2000, plots of 2m2 were fertilised with different doses of NPK (0, 120, 480 kgN/ha) in a floodplain in northern Sweden (n=8 per dose). One square meter of each plot was fertilised again in 2019-2023 while the other half was left unchanged as a control. Twenty years after the fertilisation was stopped, the plots that had been fertilised before responded faster to the new fertilisation than the plots that had never been fertilised before. Yet, the same fertilisation invoked different community changes now than in the past, and we did not observe long-lasing effects of the past fertilisation. This implies that legacy effects can be extremely long-lasting and cause stochastic responses.

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Investigating carbon stocks and exchanges through phenology, litter decomposition, and carbon fluxes

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Dwarf-shrub dominated ecosystems are important carbon sinks that are highly sensitive to climate change. However, we lack knowledge on how dwarf-shrubs respond to climate change, what role they have in ecosystem feedback to climate, and how these effects and feedback vary across the functional type. We choose 4 focal species spanning different life strategies to investigate the carbon cycle. Specifically, we will investigate how the phenology is affected by drought and the age of the ecosystem. Secondly, how leaf litter from the four focal species decompose both in a common garden and in a transplant experiment, moving in between arctic and boreal zones, continental and coastal climate, and open and forested heathlands for different microclimate. Lastly, we will investigate the carbon ecosystem exchange and stocks, and how it varies between the species with the use of removal plots in boreal, alpine, and arctic heaths and forests in Norway.

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Population genomics of fragmented mountain birch forests in Iceland

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Betula pubescens Ehrh. (mountain birch) stands as Iceland's sole forest-forming tree. Since human settlement in 874 AD, the once expansive 25,000-30,000 km2 forest has diminished to 1,200 km2 of fragmented patches. This study explores the population genetic consequences of habitat fragmentation and disturbance within these remaining birch forests. Our assessment of genetic variation within and among these forests, alongside the tracing of downy birch origin in early succession at Skeiðarársandur south of Vatnajökull through genetics, provides crucial insights. Leveraging birch genome sequencing, we seek to comprehend genetic variations essential for conservation, establish genotype-phenotype associations, and predict responses to new environmental conditions induced by climate change and emerging stressors

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Arctic climate change seen through the eyes of the Svalbard reindeer

Leif Egil Loe, NMBU / Monica Trondrud, NMBU / Samantha Dwinnell, NMBU / Tirza Moerman, NMBU / Stefaniya Kamenova, NMBU / Vebjørn Veiberg, NINA / Erik Ropstad, NMBU / Rene van der Wal, SLU /Steve Albon, Hutton Institute

Svalbard is a climate change hotspot increasing by four degrees per decade. We have studied a population of wild Svalbard reindeer in the last three decades by marking more than 1000 individuals. Since 2009, a subset has been marked with GPS-collars and since 2018 with heart rate and body temperature loggers. Our key question is if climate change helps or hurts the reindeer in this northern outpost. Our talk will explain the ecological mechanisms underpinning the three-fold population increase we have witnessed, such as improved summer forage conditions and a shorter winter season, but also novel mechanisms such as increased access to ephemeral food sources and a relaxed regulation of gut parasites. We will also show early warning signals that their “ice age” physiology force them to seek cool refuges and consequently reduce foraging activity on increasingly warm summer days. Svalbard reindeer may serve as an early indicator for climate change effects in other plant-herbivore systems.

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Does size of the parental fish affect early life phenotypic traits in the Baltic cod?

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In the last decades, Baltic cod has decreased in body size and currently attains sexual maturation at a size much smaller compared to the past. Environmental changes and fishing pressure have been pointed out as the main cause for this. Nevertheless, although cod currently successfully reproduces at the Bornholm basin and commercial fishing has been banned, the situation of the Baltic cod stock has not improved. A reduction in the adaptive capacity of produced eggs and larvae, linked to the change in reproductive fish size, has been hypothesized to be behind the lack of recruitment. In this study, we test this hypothesis by exploring whether eggs and larvae produced by small cod are maladapted and disadvantageous compared to those produced by large cod. We look at crucial phenotypic traits for their survival, such as egg and larval size and neutral buoyancy, and investigate the link between parental size, early-life adaptations, and recruitment capacity in the Baltic cod.

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Correlative species distribution modelling of near-threatened birds in Sweden

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The aim of this study is to predict the distribution of 28 near-threatened bird species in Sweden year 2020 (baseline) and 2030 (scenario assuming temperature increase of 0.4 °C). 17 environmental features that can be assumed to be highly associated with the birds' distribution were included as independent variables while citizen science observation data on 28 near-threatened bird species recorded during the breeding season in May 2020 were used as response variable. We reduced bias caused by incomplete-sampling and over-sampling in species observations by filtering data and utilized a Random Forest classifier for the species distribution modelling (SDM). The modelling results exhibited good performance of the SDM. The outputs show significant degradation of high-species-density areas due to temperature rising and other climatic changes, which may degrade the living conditions of the 28 near-threatened bird species and change their distribution patterns.

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Summarizing ecosystem service trade-offs following wetland restoration: Optimizing restoration effords

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Restoration of degraded wetlands are receiving increasing attention, partly due to wetlands holding up to 30 % of the world's organic carbon stock. To reach global zero emission goals, further drainage of wetland areas must cease, and restoration of degraded wetlands is urgently required. However, raising the water table is a dramatic ecosystem change and leads to shifts in ecosystem service (ES) supply, and currently a structured quantification of ES changes in restored areas is lacking. By collecting data from restoration projects across Europe, we aim to create an open access database on ES's provided by restored wetlands. Specifically, we will use this database to quantify trade-offs in ES supply from different wetland types with different management regimes. This will, amongst other things, aid policy makers decide on the best policies for restoration and help managers set and achieve realistic project goals. I this talk, we will present the project and our preliminary results

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THRESHOLD – Plant, soil, and ecosystem responses to global warming

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How will the functioning of terrestrial ecosystems change under projected scenarios of global warming? Will we reach or surpass thresholds and tipping points? Here, I present an update and the first results of our ERC-THRESHOLD project where we aim to advance our knowledge of how temperature responses transcend levels of ecological organization, i.e., from species to communities to ecosystem processes. We use an international network of forest-tundra and forest-alpine ecotones to assess how responses of ecosystem carbon cycling to

increasing temperature will be pushed across thresholds and tipping points. We further perform micro- and mesocosm experiments under a range of different temperatures (using climate chambers), to estimate how ecosystem process responses to warming can be predicted from the reordering of plant and soil communities.

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Exploring the Functional Traits-Fitness Relationship in Two Alpine Forbs

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My thesis examines how global warming is affecting the relationship between functional traits and fitness in two alpine forbs, Sibbaldia procumbens and Veronica alpina. Using demographic data collected over five years and trait measurements obtained in 2023 within a warming experiment along a precipitation gradient in Norway, this research explores how traits (plant height, leaf thickness, SLA, LDMC) correlate with individual growth rates and fecundity. Employing statistical models, the study aims to analyze trait variations under different climatic conditions and their implications for fitness of alpine plants. The investigation seeks to provide empirical insights into the nuanced connections between plant traits and environmental factors, offering valuable perspectives for predicting how alpine species may respond to future climate change scenarios.

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Pan-arctic lichen estimation indicates a shift from herbivory to climate change driven declines in lichen biomass

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Lichens are key components of high latitude and altitude ecosystems, contributing considerably to ecosystem functioning, carbon fluxes and total biomass. Pale lichens are also important food for reindeer, holding great ecological, economic, and cultural value. Despite the ecological, climatological and cultural importance of lichen however, there is today little knowledge about general trends in global lichen abundance, due to the previous lack of remote sensing methods. Here, using a novel remote sensing AI approach, we estimate lichen biomass trends over 35 years in 120 locations across the whole northern circumpolar region. We compare our results against existing literature and environmental datasets, investigating how lichen biomass changes differ between a) management regions, b) vegetation types, and c) drivers of vegetation change including effects of reindeer grazing and climate change.

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Plant Contribution to Ecosystem Respiration in Winter vs Summer Across an Oceanic–Continental Gradient

Rebekka Gullvåg / Emily Pickering Pedersen / Johan Olofsson / Ellen Dorrepaal. All affiliated to: Department of Ecology and Environmental Science, Umeå universitet; and Climate Impacts Research Centre, Umeå universitet

Winter CO2 fluxes have often been assigned to microbial respiration during decomposition, however, plant associated carbon may contribute more than previously assumed. Determining the source of winter CO2 emissions would provide a better understanding of the annual carbon balance of northern ecosystems, and improve predictions of changes in the large carbon pools in arctic soils upon climate change. Starting January 2024, we will conduct a field experiment along an oceanic–continental climate gradient in northern Scandinavia, to investigate how plant contribution to ecosystem respiration in winter vs. summer depend on the seasonal temperature difference – which is smaller closer to the ocean. Ecosystem respiration will be partitioned into plant and heterotrophic respiration, and will be measured mid-winter and -summer 2024. We will compare two vegetation types at each site: Heath and meadow. At Oikos 2024, I will present preliminary results from the winter field campaign.

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Exploring historical climate-growth relationships in spruce across varying site conditions in the south-east of Norway

Line Nybakken, Norwegian University of Life Sciences (NMBU) / Danielle Creek, Norwegian University of Life Sciences (NMBU)

Europe's Norway spruce forests have faced challenges from droughts and bark beetle outbreaks. In 2018, Norway experienced similar problems. The widespread planting of spruce, valued for its timber, in areas once dominated by pine may lead to increased spruce mortality due to climate change.

To better understand the climatic effect on spruce a study across a temporal gradient, from Stor-Elvdal to Aremark, was launched. It includes 10 forest plots in the southern boreal zone, each with trees averaging 40 years old. These plots are split into pairs, comparing spruce on moist to spruce on drier soils. This setup enables a examination of how varying moisture affects spruce growth. In each plot, a minimum of 12 spruce and six pine trees were cored for dendrochronological analysis. The core data, merged with local weather information and other metrics like interspecies competition, will dissect the effects of climate changes on spruce growth and resilience across varying site conditions.

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Fitness Implications of Laying Date Mismatch in a Metapopulation of House Sparrow (Passer domesticus) in Northern Norway

Sanam Bybordi Department of Biology NTNU / Yimen Gerardo Araya Ajoy Department of Biology NTNU / Thor Harald Ringsby Department of Biology NTNU / Myranda Murray Department of Biology NTNU

Climate change compromises the sustainability of ecosystems. One recurring example is the effect of temperature shifts on the timing of crucial life history events in temperate species. Leveraging over 10 years of data, we investigate how spring warming has influenced the onset of breeding and its fitness consequences in a metapopulation of house sparrows (Passer domesticus) in Northern Norway. First, we estimated the annual optimum lay day as the date with the highest fledgling success per nest for each of the nine islands. We then estimated the sensitivity of the optimum lay day to climate variables. Finally, we compared the optimum lay date and the average first lay date on an annual basis and explored the consequences of increasing phenological mismatches on population fitness. The findings shed light on the temporal movement of the optimum lay date over the study period and the impacts of climate change on breeding phenology in this system.

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The Impact of Long-term Experimental Warming and Elevation on the Sexual Dimorphism and Reproduction of Silene acaulis

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The global surface temperature has increased considerably over the last century and is expected to continue. It is found to be more pronounced at higher altitudes and latitudes, posing an important challenge for alpine ecosystems.

This study investigates the impact of climate change on Silene acaulis, a low-growing cushion plant commonly found in alpine environments. Cushion plants create unique micro-environments and are therefore crucial for these ecosystems. By comparing Silene acaulis across an altitudinal gradient and in open-top chambers (long-term experimental warming) at Finse, Norway, the study aims to examine how temperature affects flower sex expression, plant health (photosynthetic efficiency), and reproductive success. We collected data summer 2023 and will present the results at the conference. This study aims to offer perspectives on the complex interactions in alpine ecosystems, advancing our predictive capabilities for plant responses in a rapidly warming world.

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Rising peaks, shifting traits: deciphering the impact of global change on alpine plant community assembly

Sergey Rosbakh, University of Copenhagen, Denmark / Stefan Dullinger, University of Vienna, Austria / Sabine Rumpf, University of Basel, Switzerland

The global change has led to drastic changes in alpine ecosystems globally. Novel abiotic conditions and biotic interactions have re-shaped upland plant communities with far-reaching consequences. Yet, our understanding of the recent change of montane plant community assembly and their consequences for their biodiversity and functioning remains elusive.

Here, we report the changes in functional trait composition (proxies for community assembly rules) in >1400 vegetation plots over the last decades in the European Alps. We demonstrate a strong decrease in functional diversity across all vegetation belts (750-2750 m a.s.l.) suggesting relaxation of the low-temperature filter due to the recent warming. Community height, specific leaf area, leaf nitrogen content and seed mass increased across all the communities. These findings imply that the global change drivers might have improved growing conditions for upland vegetation with likely changes in their corresponding ecosystem services.

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Understanding the importance of restoration and conservation of birch woodlands from a soil point of view

Solveig Sanchez, Agricultural University of Iceland / Olafur Arnalds, Agricultural University of Iceland / Johann Thorsson, Soil Conservation Service of Iceland

Mountain birch (Betula pubescens) woodlands were key natural ecosystems of Iceland prior to the settlement. Land degradation has taken place, including destruction of most of the birch woodlands forming degraded heathlands and barren lands. EcoBirch aims for the restoration of the woodlands. This PhD project aims to study soil properties of the woodlands. Ten study areas scattered around the country were sampled where three sites were selected: old and young birch woodland, and adjacent non-forested land. Dust deposition in some of the areas has a high impact on the carbon (C) stock and bulk density: lower C content and increased bulk density. C stock in the old birch woodlands was significantly higher, more stable, fertile, better water holding capacity, and higher clay content. Forests take time to “build” and it is important to conserve them. These mature, complete ecosystems are already balanced storing great quantities of soil C being the home of a greatly varied biodiversity.

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Fisheries-induced phenotypic changes in repeatedly harvested fish populations under different temperature regimes.

Stephan van Dijk - University of Jyväskylä / Daniel Sadler - University of Jyväskylä / Phillip Watts - University of Jyväskylä / Silva Uusi-Heikkilä - University of Jyväskylä

Size-selective fishing favors fast juvenile growth, small adult body size and low reproductive output together with evolutionary changes, which can be slow to reverse. To study the recovery potential of exploited experimental populations, we compared life-history traits of three size-selected lines (large-selected, small-selected, randomly-selected) after 5 generations of harvesting, 10 subsequent generations of recovery and another 5 generations of re-harvesting. After a recovery period twice as long as the harvesting period, the phenotypic differences among the selection lines had eroded while genomic differences remained. We show that, despite evolutionary changes in exploited fish populations, the populations can phenotypically recover. To study the effect of an interacting stressor on re-harvested fish populations, we exposed the selection lines to thermal stress. We expect size-selected fish to perform worse under challenging temperatures than non-size selected fish.

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Warming alters the top–down effect of a common mesopredator in an aquatic food web

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Global warming is reshaping terrestrial and aquatic ecosystems, with limited research on indirect effects through species interactions. Investigating the Baltic Sea food web, our study manipulated temperature and the presence of threespine stickleback and found the stickleback to alter the impact of warming on lower trophic levels. This was through increased consumption of herbivores that exceeded the rate at which the herbivore population could grow under higher temperature, which in turn increased algae biomass. Thus, the mesopredator increased the transfer of biomass to higher trophic levels of the food web when temperature was increased. This stresses the importance of considering the impact of warming on multiple trophic levels and their interactions. Failing to consider differences in responses among trophic levels and the impact this has on their interactions can result in faulty conclusions about the impact of warming on ecosystems.

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Genomic Offset for Rock Ptarmigan in Response to Climate Change

Theodore Squires, University of Akureyri and Uppsala University / Patrik Rödin Mörch, Uppsala University / Jacob Höglund, Uppsala University / Kristinn Pétur Magnússon, University of Akureyri and the Icelandic Institute of Natural History

In the face of ongoing global climate change organisms must rely on standing genetic diversity for adaptation. To this end, there is a conservation imperative for understanding the genetic adaptability of species and populations. Using whole genome re-sequencing data we study the effects of climate influenced declines in effective population size on the accumulation of deleterious mutations and the response to future climate change in populations of a cold-adapted avian species from the Holarctic: the Rock Ptarmigan (Lagopus muta). We reconstruct the demographic histories of seven populations and determine their nucleotide diversity, past and present inbreeding, and mutation load. Genomic vulnerability to future climate change scenarios (also known as offset) is predicted for the populations. We show that relatively small and isolated populations have reduced nucleotide diversity, higher signatures of past inbreeding, higher genomic offset, and higher estimates of mutation load.

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Experimentally increased food availability speeds up fuelling and advances spring departure in a migratory shorebird

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In a warming climate, migratory animals are under pressure to adjust their timing of migration and reproduction. The most effective way to achieve earlier arrival on breeding areas is by departing earlier from nonbreeding areas, yet this is rarely observed. We studied whether timing of departure is constrained by time and resources required for spring migration preparation in red knots Calidris canutus which were taken into captivity, exposed to various food levels during the fuelling and moulting phase, followed by release and tracking to determine timing of spring migration departure. With longer access to food, birds sped up migration preparation and were heavier and further into summer plumage at release, and these birds also departed earlier from the Wadden Sea. This implies that speed of migration preparation, including mass and plumage change, as well as departure timing are flexible, with food availability forming a constraint that may limit advancement of departure timing.

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Seasonal changes of plankton community in a subalpine oligotrophic lake

Thomas C. Jensen (Norwegian Institute for Nature Research, NINA) / Birger Skjelbred (Norwegian Institute for Water research, NIVA)

Winter conditions in arctic and temperate regions are changing rapidly and there is an increasing awareness of the importance of the ice-covered winter period for high latitude lakes. Still, winter ecology in these lakes is an understudied subject. For example, few investigations report on the seasonal changes in plankton composition during the ice-covered winter months. This study examines monthly changes in plankton communities during two summers and the winter in between in an oligotrophic, subalpine ice-covered lake (Lake Atnsjøen) in SE Norway. Compared to the open water period winter phytoplankton and zooplankton species composition under the ice was clearly different with a lower species richness. Furthermore, there were also differences in functional composition between winter and the open water period. Hence, the study illustrates some of the characteristics of winter plankton communities but it also shows that winter is not only an unimportant period of dormancy.

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Microbial life history strategies are disconnected from microbial resilience after rewetting of dry soils

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Environmental gradients have been hypothesized to shape changes in microbial life history strategies and resilience after rewetting or dry soils, but this hypothesis has not been tested. We collated 123 time-series of microbial growth (G, sum of fungal and bacterial growth) and respiration (R) after rewetting, and calculated carbon use efficiency, CUE=G/(G+R). Using the fungal fraction (fungal growth over G) and substrate uptake rate (G+R), we characterized changes in microbial life history strategies in the high yield (Y)-resource acquisition (A)-stress tolerance (S) framework. Then, we characterized microbial resilience to drought by estimating the speed of CUE recovery at rewetting. Next, we predicted microbial strategy shifts and

resilience to drought along environmental gradients. Environmental conditions shape microbial strategies after rewetting but do not affect resilience, indicating that microbial resilience may be disconnected from microbial strategies after rewetting.

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Evaluation of the impact of wetland revitalization on the species Leucorrhinia pectoralis in the Záhorie region

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Thanks to specific conditions, the Záhorie region (western Slovakia) is rich in the occurrence of diverse wetland ecosystems, including rare peatlands. They were massively drained in the past. In the years 2005-2008, revitalization took place in selected sites. One of the project target species was the dragonfly Leucorrhinia pectoralis. In this work, its population was evaluated in 5 selected sites in the period before and after the revitalization. One of the results was the detection of significant fluctuations in the species abundance. Since it is a species with bioindicative potential, we also evaluated the changes in habitat under the influence of climate change over the years to see, if there is any connection. For this purpose, long-term time series of Landsat satellite imagery was used to assess NDWI and NDVI trends and the interannual changes in their spatial characteristics. In conclusion, the observed trends were compared with the faunistic data for the overall evaluation.

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Understanding the reproductive dynamics of Eucalyptus globulus clonal trees

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Eucalyptus globulus Labill. is one of the most widely planted forest trees for the pulp and paper industry. In Portugal, this exotic species occupies ca. 25% of total forest cover, and concerns arise about its ability to naturally regenerate outside plantation areas. Forest tree improvement programs have been developed to promote the growth, adaptability, and wood quality of this economically significant species. This study evaluates the phenological behaviour and reproductive structures production of clonal trees, crucial for seed dispersal, by comparing clonal and seedling-based trees under different climatic conditions in Portugal. Clonal trees exhibited varied reproductive structure production, often lower than seedling-based trees, and a greater sensitivity to climatic conditions. Our findings offer insights into the dispersal potential of E. globulus clonal plantations in introduced areas, aiding decision-making for plantation establishment in Portugal.

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Ecosystem resilience: The impact of land use changes on soil properties.

Berglind Gudjonsdottir / Johann Thorsson / Kristin Svavarsdottir

Changes in land use can affect ecosystem properties. Here, we report results on soil properties after woodland removal and later grazing removal. The area consists of heathlands with adjacent pristine birch woodland and seedlings establishing within the ecotone. Little signs of degradation or erosion were present. Special focus was given to spatial components, elevation and distance from the woodland.

Results show unusually high carbon in heathland soil. Recent birch colonization was not observed changing C or N in soils and negligible impact detected of a 15-year period without grazing. C and N levels were lowest near an old farmstead, suggesting a piosphere effect. Soils under pristine birch woodlands and soils within the birch ecotone were more similar than for soils further away.

This suggests that soil properties, such as C and N, can be long-lasting given that degradation following disturbances doesn't cross a critical threshold, emphasizing the importance of sustainable land use.

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Novel Map of Swedish Primary Forests

Camille Volle, Department of Physical Geography and Ecosystem Science, Lund University / Anders Ahlström, Department of Physical Geography and Ecosystem Science, Lund University

Primary forests have intrinsic value in their ability to define natural states and dynamics without any anthropogenic influence. However, primary forest maps of high quality are lacking, and in Sweden there is no official map. In this study, we present a novel map of Swedish primary forests created with historical records and remote sensing. In Sweden, 4% of the forest land area can be classified as primary forest. Here, we present a spatial analysis of the location and naturalness of Swedish primary forests. While productive-mountainous primary forests have been protected by their remote location, there is no current explanation as to why the lowland ones remain largely untouched. Hence, we explore several spatial factors which could explain their preservation and also evaluate their representativeness of the managed forest dominating the landscape. With our research, we aim to identify any patterns, and facilitate the identification of areas with varying degrees of naturalness.

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BorealNet- Norwegian finescale growth monitoring network

Danielle Creek, Norwegian University of Life Sciences / Johan Asplund, Norwegian University of Life Sciences / Hans Ole Ørka, Norwegian University of Life Sciences / Terje Gobakken, Norwegian University of Life Sciences / Attila Nemes, Norwegian University of Life Sciences / Isabella Børja, Norwegian University of Life Sciences and NIBIO / Line Nybakken, Norwegian University of Life Sciences

We will introduce you to BorealNet, where we are establishing a state-of-the-art, long-term forest monitoring and research network for Norway. Autonomous, high frequency dendrometers will be installed at spruce-dominated sites across Norway, generating high temporal datasets of tree growth, health, and tree water dynamics. Long-term trends as well as fine scale feedbacks between tree growth, climate, water balance and soil will be investigated to provide a mechanistic understanding and fill information gaps in the key drivers of spruce forest health. We will link individual tree growth data to entire landscapes through remotely sensed vegetation and climate data and in turn, the high-quality and long-term growth data sets obtained from BorealNet will form the basis of ground truthing and validation for remote sensing models and algorithms. This near-real time information about tree growth and stress will help us understand forest ecosystem responses to climate change.

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Seasonal plant nitrogen uptake in the subarctic winter

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The subarctic is characterized by long periods of cold and dark conditions and often blanketed by a snow cover. These conditions have led to the assumption that plants are primarily dormant. However, snow-cover can decouple the subnivean conditions from air temperatures with potential consequences for the conditions for plants.

We thus studied plant potential nitrogen (N)-uptake across a whole year through 15N-addition every four weeks. Three weeks after each injection we measured the recovered 15N found in plant parts (above- and belowground) and microbial biomass. Throughout the year 10-20% of the recovered 15N were found in plants and 80-90% were found in microbes, with no clear difference between the snow-covered and the snow-free part of the year.

Our results demonstrate that plants have a potential to utilize available N irrespective of time of year, and that the so called dormant season might be more important in plant-soil nutrient dynamics than previously assumed.

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The origin of the oak seedling microbiome.

Lisse Goris Stockholm University / Ayco Tack Stockholm University / Chandrasekar Ramanathan Stockholm University

While the plant microbiome plays a major role in plant growth, defense and resistance against diseases and herbivores, we lack insights into the assembly process of the plant microbiome.

In this study, we investigated the relative contributions of horizontal and vertical transmission to the fungal microbiome of pedunculate oak (Quercus robur) seedlings. We designed a reciprocal multifactorial experiment where acorns from three different mother trees were exposed to a combination of a soil microbiome and a leaf microbiome originating from one of the mother trees. We measured growth and leaf characteristics during the experiment, and after nine weeks we collected leaves and roots for genetic analysis of the fungal microbiome. The results of this experiment demonstrate how microbes present in the seed, soil and canopy jointly shape the seedling microbiome and seedling growth characteristics in Quercus robur, thereby increasing our understanding of the microbiome assembly in plants.

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Linking plant communities with water-related ecosystem functions after peatland rewetting

Sahra Karin Ingrid Gibson, Department of Plant Ecology, Evolutionary Biology Center, Uppsala University.

Vegetation composition development after peatland rewetting is pivotal for determining the success of the rewetting, as plants regulate nutrient retention, peat formation and thus hydrological properties. These functions depend on the plant traits, and plant communities can thus be used to make quantitative predictions on water-related ecosystem services. The aim of this PhD project is to establish quantitative links between plant functional traits and hydrological processes in boreal peatlands after rewetting. Between 2024 – 2027, I will measure vegetation composition and functional traits in relation to plot-scale pore water quality, and downstream water quality, while controlling for peat characteristics and hydrological status, across a chronosequence of rewetted projects in Sweden and Finland. I will introduce the objectives and methodology design in this poster.

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Applying forensic methods to detect the number and extend of individual fungal mycorrhiza in environmental DNA samples

Shuangshuang Wang, Department of Organismal Biology, Systematic Biology, Uppsala University / Anna Rosling, Department of Ecology and Genetics, Evolutionary Biology, Uppsala University / Elisabet Ottosson, The Swedish Species Information Centre, Swedish University of Agricultural Sciences / Martin Ryberg, Department of Organismal Biology, Systematic Biology, Uppsala University / Tobias Andermann, Department of Organismal Biology, Systematic Biology, Uppsala University

We commonly identify fungi based on their above-ground fruiting bodies, yet the true extent of their underground mycelium remains largely unknown. Here, we aim to develop an assay using environmental DNA (eDNA) from soil samples to identify and distinguish fungal individuals through the use of short tandem repeat (STR) sequences, typically used in forensics. Our pilot study focuses on Gomphus clavatus, an ectomycorrhizal fungus and indicator species of old-growth forests. We identify 296 STR loci from the genome of G. clavatus and test loci with intraspecific variation by experiment and analysis of 32 de novo genome sequences for G. clavatus. We use these highly variable STR loci to construct a multiplex STR assay to be able to genetically distinguish individual specimens from the same forest. This approach will explore intra-specific diversity, the distribution, and extent of individual mycelia, and offers a pipeline for applying forensic techniques in environmental DNA analysis.

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Warming influences carbon and nitrogen assimilation between a widespread Ericaceous shrub and root-associated fungi

Stefan F. Hupperts (Department of Forest Ecology and Management, Swedish University of Agricultural Sciences)/Kazi Samiul Islam (Department of Forest Ecology and Management, Swedish University of Agricultural Sciences)/Michael J. Gundale (Department of Forest Ecology and Management, Swedish University of Agricultural Sciences)/Paul Kardol (Department of Forest Mycology and Plant Pathology, Swedish University of Agricultural Sciences)/Maja K. Sundqvist (Department of Forest Ecology and Management, Swedish University of Agricultural Sciences)

High-latitude ecosystems are warming faster than other biomes and are often dominated by a ground layer of Ericaceous shrubs, which can respond positively to warming. In a glasshouse setting, we examined the effects of warming on the carbon(C)-for-nitrogen(N) exchange between the Ericaceous shrub Empetrum nigrum ssp. hermaphroditum and its root-associated fungi. We applied different 13C and 15N isotope labels, including a simple organic N form (glycine) and a complex organic N form (moss litter) and quantified their assimilation into plant biomass and root fungal biomass pools. We found that warming lowered the amount of 13C partitioned to root-associated fungi per unit of glycine 15N assimilated by E. nigrum, but only in the short term. However, warming increased the amount of 13C partitioned to root-associated fungi per unit of moss 15N assimilated by E. nigrum. Our study indicates that warming affects the C-for-N exchange between a common Ericaceous shrub and root-associated fungi.

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Seed production in Swedish stands of the invasive alien plant Japanese knotweed

Tina D'Hertefeldt, Högskolan i Halmstad / Annette Andersson, Lund University

Invasive Alien Species (IAS) pose a threat to biodiversity in all regions on Earth, and climate change is expected to accelerate the risks of IAS. In Northern regions, long winters and low temperatures have been assumed to render these regions relatively unaffected by IAS. For example, alien plants colonizing Northern regions may have sexual reproduction functionally prevented by loss of pollinators and/or restrictions in growth period. This conforms with the notorious IAS Japanese knotweed (Reynoutria japonica) that reproduces by rhizomes in Scandinavia but lacks male pollen donors here. However, this autumn-flowering plant has recently been observed to produce seeds in Sweden. We studied seed occurrence, quality and germination from 7 R. japonica stands. All stands flowered and produced some seeds. Seeds from 2 stands were filled, suggesting germination potential. We present results from germination tests in the context of co-occurring R. japonica, R. sachalinensis and R. × bohemica.

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Satellite-based optical and radar remote sensing of dominant tree species in Swedish forests

Abdulhakim M. Abdi, Centre for Environmental and Climate Science, Lund University

Forests covers 70% of Sweden, and there around 87 billion trees according to Swedish Forest Industries. Norway Spruce (Picea Abies), Scots Pine (Pinus silvestris), and Birch (Betula spp.) represent 92% of the standing timber volume. Developing an efficient country-wide monitoring protocol of this resource is essential for maintaining ecosystem services and economic viability, as well as land management and biodiversity conservation. This presentation shows preliminary results of dimensionality reduction and clustering techniques to detect thresholds of separation between spruce, pine and birch in terms of their spectral reflectance and radar backscatter. This work also evaluates the role of forest properties such as tree height and volume in influencing the spectral reflectance and radar backscatter observed by the satellite sensors.

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Beat the heat - The importance of soil water for cooling trees

Caroline Greiser, Stockholm University / Giulia Vico, Swedish University of Agricultural Sciences / Lucia Hederová, Czech Academy of Sciences / Jan Wild, Czech Academy of Sciences / Martin Macek, Czech Academy of Sciences / Martin Kopecký, Czech Academy of Sciences

Forest canopies can create cool microclimates by shading the ground and by evaporating soil water. Microclimate cooling is an important ecosystem function that is threatened by drier summer climates, harvesting and drainage. We ask: Do wetter soils lead to cooler forests? Which forests lose their cooling function during dry spells? We studied the temperate forest in central Europe and used a network of 57 loggers measuring sub-canopy air temperature and soil moisture. For each logger, and across 4 summer seasons, we calculate daily maximum temperature differences from reference weather station. In our statistical models, we found a strong cooling effect of soil moisture. But the link between moisture and cooling depended on canopy cover, topography-modified incoming solar radiation and general weather. If forests start losing their cooling capacity, we expect to see cascading effects on forest ecosystem processes and understory biodiversity.

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Ecosystem services of thermophilous grasslands of Cerová vrchovina (Slovakia) under different land-use practices

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The xero-thermophile grasslands are nowadays one of the most threatened ecosystems in Europe as well as in Slovakia. On the other hand, they are important also by providing several specific ecosystem services, which are influenced by different forms of land use practices and their intensity. We present in this paper the inductive approach to ecosystem services evaluation. We performed the analysis of semi-natural dry grasslands and fringes in the Eastern part of Cerová vrchovina according to plant functional traits, and other attributes of each phytocenological relevés. We focused on selected ecosystem services, those are forage, melliferous potential, medical use, diversity, and nature conservation importance, representing the potential of providing ecosystem services. The goal of this analysis is to compare the potential of providing selected ecosystem services with different land-use practices intensity represented by abandonment, extensive, and intensive land-use practices.

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Drastic decrease in clear-cutting age in Swedish forests: Effects on ecosystem services

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The age of clearcutting in Swedish forestry has decreased by approx. 10 years during the last two decades (from 107 to 98 years), after having been fairly stable for 30 years, as shown by data from the Swedish National Forest Inventory from 1983 to 2022. This is not caused by increased damages from storms and pests that may force forest owners to cut their forests before the economically optimal harvest age. Rather, the decrease in clear-cut age is even larger when excluding plots harvested because of damages (>15 years since 2003), suggesting that it is caused by industry-driven intensification of forestry. Combining these results with earlier studies of the NFI data, we show that decreases in harvesting age has negative effects on many ecosystem services of value for society, e.g., production of berries and game, biodiversity, and most likely also carbon sequestration and storage, and other ecological processes.

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Using the invasive Acacia longifolia as a Green-waste compost: an integrative approach focused on soil improvement

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Climate change and unpredictable forest fires are shifting the focus of ecosystems' recovery research to a holistic point-of-view. Sustainable strategies are required for biodiversity conservation, especially considering the soil's perspective. Embracing the principle of circularity, Green-waste compost (Gwc) production from the invasive plant Acacia longifolia for soil recovery can be a win-win solution, but understanding its impact on plant communities over time is crucial. This study addresses the influence of adding Gwc by assessing rhizospheric soils and microbial communities, across two periods of plant development in a Mediterranean scenario. Findings validate the use of Gwc to improve soil properties and allow an efficient seasonal dynamic of the microbiome, enhancing plant growth. This emerges as an integrative approach to cope with soil erosion and increasing dryness along with biological invasions, especially in the Mediterranean region, targeting biodiversity conservation.

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From ecosystem services to a true sustainable crop – the journey of Corema album (L.) D. Don

João, Jacinto1,2 / Carla, Alegria1/ Teresa, Valdiviesso2 / Pedro, Brás de Oliveira2 / Mari Cruz, Díaz-Barradas3 / Ana Rita, Varela2 / Filomena, Nóbrega2 / Cristina, Máguas1 -- 1 Centre for Ecology, Evolution and Environmental Changes (cE3c) & CHANGE-Global Change and Sustainability Institute, Faculty of Sciences, University of Lisbon, Campo Grande, 1749-016 Lisbon, Portugal -- 2 Instituto Nacional de Investigação Agrária e Veterinária, I.P. (INIAV), Oeiras, Portugal, Av. da República, Quinta do Marquês, 2780-157, Oeiras, Portugal -- 3 Departamento de Biología Vegetal y Ecología, Universidad de Sevilla, Spain

Agriculture is facing a lot of pressures due to extreme environmental conditions. Finding new varieties and, potentially even, new crops are crucial for more sustainable practices. Plants that are adapted to harsh conditions, for example drought stress and poor soils, might be good candidates to new crops. The white crowberry, Corema album (L.) D. Don (Ericaceae), is an evergreen shrub found in the

west and south Atlantic coast of Portugal and Spain. Consumed locally and used in folk culture, they are known for their white berries, with a pleasant fresh and lemony taste, rich in antioxidants and high in phenolic content. Moreover, the species adaptation to a sand dune ecosystem shows how resilient it is. This work will help to highlight, how the white crowberry's traits can surpass the ecophysiology of the plant, proving to be an interesting candidate for a future crop.

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Lendisbati - the first large Ecological restoration initiative in the Faroe Islands

Kolbrún í Haraldsstovu, Head of Department of Botany, the Faroe Islands National Museum

The Faroe Islands are situated in the North Atlantic Ocean. Heavily affected by grazing and harsh weather conditions, the nature is exposed to multiple environmental pressures. Before settlement, marshes and scrublands covered major areas. But with the introduction of sheep, monotonous grasslands now dominate. The Faroese landscape is often portraited as purely untouched although the scars of peat cutting are evident, and erosion a common sight. Furthermore, climate change continues to put pressure on the Faroese nature. Thus, prevention of further land degradation is critical. Lendisbati is the first large ecological restoration initiative in the Faroe Islands. The initiative aims to prevent erosion, increase biodiversity, and restore wetlands for carbon storage. Lendisbati collaborates with local farmers, several national and international institutions and receives funding from different organizations. There are ongoing projects which the poster will highlight.

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Under-explored carbon and nutrient cycling in alpine cryptogams

Robert Mills, University of York

Alpine cryptogams are often overlooked, especially so in their role in cycling of litter, with models assuming litter decomposition mainly takes place in soil. Using insights from litter-degrading enzymes, I show that Cladonia arbuscular invests in plant-litter degradation which is further enhanced by proximity to key alpine shrub species. I will discuss the potential implications of this, and make a call to the community to embark on a study to search for it generality, and sensitivity to changing climate and community ecology.

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Using VOCs to asses soil health

Rosa Boone, Radboud Institute for Biological and Environmental Sciences, Nijmegen (NL) / Bjorn Robroek, Radboud Institute for Biological and Environmental Sciences, Nijmegen (NL) / Hans de Kroon, Radboud Institute for Biological and Environmental Sciences, Nijmegen (NL)

The shift towards sustainable agriculture would benefit from tools to assess soil biological health. Microbial community composition and activity make ideal proxies for soil health as they are shaped by soil conditions. Additionally, soil microorganisms produce a wide diversity in volatile organic carbons (VOCs), which can be extracted directly from soils. This project aims to link VOC profiles to soil microbial communities in grasslands under different management regimes (Conventional, Extensive and Semi-natural). We collected VOCs and the soil fungal and bacterial communities in 18 grasslands. A Random Forest analysis was used to distinguish indicative VOCs between management types. Using a Joint Species Distribution Model, we explored how differences in VOC profile related to changes in microbial communities. Preliminary results suggest differences in VOC profile between grasslands under different management.

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Using the Past to Predict the Future: The Effect of Past Management on Current Condi□ons of Salt Marshes

Camilla Weje Hangstrup & Camilla Hebsgaard. Affilia□on: Aalborg University, Aalborg, Denmark

The global rise of sea levels poses a threat to coastal ecosystems such as salt marshes, due to the phenomenon known as “Coastal Squeeze” where coastal habitats are prevented from migrating further into land due to man-made structures such as buildings but also agricultural structures. In order to allow this ecosystem to persist, it is crucial to allow the salt marshes to migrate further in land. In order to (re)establish saltmarshes on areas currently not meeting the criteria for a salt marsh, it can be beneficial to take historical management and soil characteristics into account, in order to determine whether it is possible for the area to become a salt marsh in good condition. During spring and summer of 2023, data from 80 plots on five different salt marshes with different management history (behind a dam, untouched – low vegetation, untouched – tall vegetation, cultured, and best salt marsh condition by abiotic standards) has been collected. From these plots botanical analyses, nature evaluations as well as abiotic soil analyses have been performed to determine relationships between historical management and current conditions of the salt marshes. The objective of this research Is to determine if past historical management can be used as a factor to predict future condition of the restoration/creation of ecosystems.

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Impacts of Air Pollution on the Immune Assay of Great Tits and Blue Tits in Urban and Rural Areas

Danyang Wang, Department of Biology, Lund University / Susana Garcia Dominguez, Dept of Biology, Lund University / Caroline Isaksson, Department of Biology, Lund University

Birds are facing environmental changes in cities, among which air pollution is a significant change linked to human activity and urbanization. Great tit (Parus major) and Blue tit (Cyanistes caeruleus) are small passerines well adapted to city life. We measured the concentration of PM2.5 and NO2 in five urban city parks in Malmö, and three rural sites, including Dalby Norreskog and Skrylle Naturreservat. A total of 452 Blood samples were collected from great tits and blue tits using the nest boxes near the air samplers during breeding season 2023. Females and three chicks per brood were sampled if possible. We used two immune assays: haptoglobin (Hp), a biomarker of an ongoing inflammatory response indicating immune status, and haemagglutination-haemolysis (HLHA), which enables the quantification of complement and natural antibodies. We aim to address potential differences across assays, life stages and species in response to urbanization and air pollution levels in future analysis.

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Effects of spring timing on the dynamics of a freshwater zooplankton community

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Spring is considered a decisive season for temperate communities. Changes in the onset of spring affect species' phenology and in turn community structure and composition. The magnitude of this effect may depend on individual traits. For species with multiple generations in a year, such as most zooplankton, the effects of spring timing might not be so strong.

Here, we use a GLMM approach to study community dynamics, based on stochastic community models. We estimate the effect of spring timing on a freshwater zooplankton community. The model elucidates the spatiotemporal dynamics of the species abundance distribution (SAD). It enables the decomposition of this variation into factors such as species heterogeneity and environmental stochasticity.

Previous analyses have shown that species heterogeneity and species-specific, within-year environmental effects had the largest impact on the variance of the SAD. The current study demonstrates the effect of spring timing on this variation.

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Soil carbon, microbes, a math mess, and ecological consequences

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Soil organic carbon (SOC) fate is an important part of the global carbon cycle and directly controlled by biota. However, SOC models do not incorporate our understanding of these dynamics, especially of the microbial control on SOC fate. We evaluated the stability of equilibria, an important mathematical property and potential pitfall of microbial-explicit models: microbial-explicit models can be

unstable, meaning that they are not resilient to a perturbation from their equilibrium. If applied at large spatial scales, this can lead to unrealistic predictions. We found that instability can occur when the resupply of a growth substrate is, via positive feedback loops, mostly dependent on its own abundance. The microbial community could then go extinct. Conditions with low substrate input, high leaching rates, or low kinetic rates are prone to instability. Considering that microbial communities would adapt or shift with environmental conditions can avoid instability of these models.

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Towards a process-based understanding of macroecological pattern and process with focus on biotic interactions

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Macroecology studies large-scale biodiversity patterns and processes. However, process-based methods to explain broad biogeographical patterns are largely missing. Processes like consumer-resource dynamics, dispersal rates, and density-independent climatic effects influence the distribution of species, trophic communities, ecosystem functioning and, ultimately, the services provided by nature to society. We present a metacommunity framework that integrates density-dependent biotic interactions, group-specific dispersal functions, and environmental heterogeneity to generate predictions for species distributions, community dynamics, and ecosystem functioning. Particularly, we aim to understand the influence of biotic interactions in shaping higher-level community characteristics. By providing a mechanistic understanding of pattern formation in macroecology, our model offers a new avenue to address the pressing need for improved models of biodiversity change under climate change.

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The aquatic fauna of the North Atlantic islands. Species distribution in relation to climate and migration routes

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During the last glacial maximum, 25 Kyr ago, ice sheet covered the North Atlantic Islands, Scandinavia into N-Europe and Britain north of London. During this time ice sheet extended as far as 100 nautical miles off the present coast of Iceland. Most likely no aquatic invertebrates survived, with the exception of newly discovered 2 species subterranean amphipods in the groundwater system of Iceland. It is evident from mitochondrial DNA that one of the species has been on the island for at least 5 million years. Other invertebrates have presumably colonized the islands after the

Ice-Age, 10 Kyr ago. Their origin is Scandinavia and Britain and it has been possible to follow the colonization route of one Trichoptera species from Central-South Europe migrating along the W-Europe through Britain and Faroe Islands to Iceland, where as another parthenogenic Trichoptera originated near the Bearing Straight and one population migrated westward through N-Asia to Scandinavia to Iceland, where another population migrated eastward through N-America, Greenland to Iceland, where the populations meet without reproducing. The number of species on the North Atlantic Islands is a result of the distance these islands are from the larger regions of Western Europe rather than the sizes of the islands. For aquatic insects, about 5% of the Norwegian or British fauna is found on the Iceland, the island furthest away from these regions, whereas about 30% of the Cladocera (Crustacea) are found, but they have a resting eggs which can be transported by waterfowl. Also, the North Atlantic islands have only a few of the species in common, indicating the stochastic nature of the colonization.

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Invertebrates in northern Jutland

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My masters project revolves around investigating the invertebrate communities of salt meadows and fresh meadows of Northern Jutland. Vejlerne is a nature reserve in northern Jutland that contains one of Denmarks largest varieties of native and migratory bird reservoirs. Lately there have been some some concerns regarding the amount of birds found in the western part of the reserve as the amount here is much lower than in the eastern part. One of the potential reasons for this could be a lack of available food for the birds, and given recent studies of the status of flying invertebrates one of the main food sources that could be under pressure could be insects (Hallmann C, et al., 2017). Therefore, the project revolves around collecting insects from the summer of 2023 and investigating the biomass of all invertebrates and the species diversity of specificily Coleoptera. Another thing my project considers is whether or not the historic use of the areas can have an effect on the current status of the meadows. Different management methods have been used throughout the years and have created local differences between the meadows in the area.