Book of Abstracts

50th Anniversary Conference

GfÖ

The Ecological Society of Germany, Austria and Switzerland

Ecology

Science in Transition, Science for Transition

30th August – 1st September 2021, Braunschweig

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Landscape Ecology and
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WELCOME NOTE

"Welcome to the 50th Conference of the Ecological Society of Germany, Austria and Switzerland in Braunschweig". This is how I would have liked to welcome you all personally last year. I would have smiled at you from one of the first pages of a printed volume of abstracts and, on the fringes of many good conversations and personal encounters with hopefully many of you at the conference dinner, toasted the 50th birthday of our Society. As we all know, things turned out differently. Nevertheless, I would like to welcome you no less warmly to what is, if possible, a unique event - the first purely virtual conference of the GfÖ.

Rarely has the theme of a conference fitted the times better than this year. "Ecology - Science in Transition, Science for Transition" not only describes the processes of change in the communication of science itself, which were triggered by the pandemic, but also the necessity of science-based policy changes, without which we will hardly be able to solve the huge problems of our times. For example, the transformation towards a more sustainable resource-use of our planet, measures to counteract climate change and the ongoing loss of species will not be possible without contributions from ecology. Here, new formats of communication will presumably play a much greater role than before. Therefore, and here we come full circle, it may be even good that we were forced by the pandemic to meet only online for this year's conference: we can gain experience in the virtual exchange of results, of expert discussions and of orienting conversations, which will help us elsewhere in communicating the most relevant findings of ecology to society and politics. And so, I hope that you will engage in the great experiment of a purely virtual conference, get involved and let us know what could be done differently and better if we had to repeat this format, whenever. Above all, I wish you days full of insights and hope that the rich programme will find your interest also and especially this year. I would like to take this opportunity to thank the organisers of this year's conference, Jens Dauber and Boris Schröder-Esselbach, because without their willingness to try something new and to accept the challenge of a virtual conference, our meeting would have had to be cancelled again this year. Hopefully, against the background of the now expanded possibilities of exchange, this will not happen again in the up-coming 50 years.

Christian Ammer

President of the GfÖ

WELCOME NOTE

Dear colleagues and friends, dear guests,

we would like to welcome you to the 50th Annual Meeting of the Ecological Society of Germany, Austria & Switzerland. The Technische Universität (TU) Braunschweig and the Johann Heinrich von Thünen Institute in Braunschweig jointly host this anniversary meeting. As the conference has to take place in a virtual format, we have tried to provide the best possible platform with a variety of interaction possibilities. The program guarantees top-class key notes, exciting workshops and many worthwhile talks and poster presentations and altogether almost 300 contributions and 400 participants, despite the special circumstances.

Even if we cannot see each other personally in Braunschweig, we are very happy that we can celebrate the 50th GfÖ birthday together in a graceful setting. Hopefully, you'll find another opportunity to visit the beautiful Lion City with its long history - first mentioned in 1031 – and magnificent highlights such as Dankwarderode Castle and St. Blasii Cathedral in the heart of the city or the green banks of the Oker River encircling the inner city. Braunschweig rightly calls itself the City of Science. More than 15,000 people work and conduct research in 27 (federal) research institutions, such as PTB, DLR, HZI, JKI and, of course, Thünen Institute and TU Braunschweig.

Last year we celebrated the 275th anniversary of TU Braunschweig, which got its name in 1968. Altogether 120 institutes organised in six faculties educate more than 18,500 students in almost 50 degree programs. One of these programs in the Faculty of "Architecture, Civil Engineering and Environmental Sciences" is "Environmental Sciences", which started as "Geoecology" in 1989 and is offered in large parts by the Institute of Geoecology with its five divisions, two of them hosting this year's Annual Meeting: Landscape Ecology and Environmental Systems Analysis and Biodiversity of Agricultural Landscapes (jointly established with the Thünen Institute of Biodiversity).

The Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, is a German research institute under the auspices of the German Ministry of Food and Agriculture (BMEL). It develops scientific basics as decision-making helps for the policies of the German government. Historically, Thünen bases on – among others - the Federal Agricultural Research Centre (FAL, founded in 1948).

Our anniversary meeting has the motto: "Ecology – Science in Transition, Science for Transition". We all agree that ecological sciences play an important role in dealing with the recent and unprecedented challenges of global and climate change, biodiversity loss, and sustainable development. We want to take a look back at the developments in ecology over the last 50 years and at the same time critically examine the extent to which these developments have made ecology fit for the scientific and socio-political challenges of the changes that are currently occurring or becoming necessary in almost all habitats.

Finally, we would like to thank the many people who have contributed to the successful organization of the virtual meeting. First of all, we would like to mention Dania Richter, Jolan Hogreve, Viviane Borchert, Wiebke Sickel, and Frank Suhling for their indispensable help in organising the meeting, together with KCS Heike Kuhlmann and the Event-Tech Team. Many thanks to the keynote speakers for their inspiring lectures as well as the chairs of the various sessions for suggesting stimulating topics. We hope that this virtual meeting will offer an inspiring atmosphere for fruitful discussions and interactions.

Boris Schröder-Esselbach and Jens Dauber

Local Organising Committee & Scientific Committee

1. AWARD KEYNOTE

My journey into biodiversity research

Bernhard Schmid

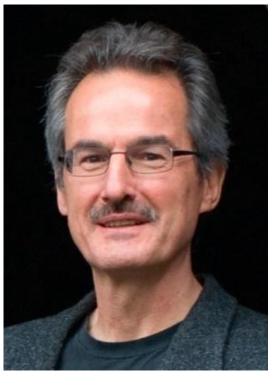
Professor at the University of Zurich, Switzerland

Bernhard Schmid started his ecological career working on the life history of *Carex flava* for his PhD at the University of Zurich. He then moved on to post-doctoral research with two of the leading plant population ecologists of the time, John Harper in Bangor, Wales and then Fakhri Bazzaz at Harvard. He returned to Switzerland as Professor of Conservation Biology at the University of Basel before being appointed Professor of Environmental Sciences at the University of Zurich. He is also an adjunct Professor at Peking University, China. Bernhard has conducted groundbreaking research in several areas of plant ecology, most notably on the population ecology of clonal plants, mechanisms of competition, community assembly, and more recently on biodiversity-ecosystem functioning relationships. Research pioneered by Bernhard Schmid has proved that ecosystems with higher genetic or species diversity are more productive, more efficient and more stable in the face of environmental changes. This discovery countenances for movement away from the dominant use of less diverse systems and monocultures in agriculture, and towards management for high combining ability among genotypes and species. Specific research outcomes include: species-rich grasslands have increased productivity and soil fertility if species with high combining ability are used, breeding and genetic engineering for high combining ability among genotypes can break yield stagnation in major crop plants, planting mixed-species forests instead of monocultures can double the amount of fixed carbon per area, managing for biodiversity provides spatial and temporal insurance for agro- and forest ecosystems, diverse ecosystems reduce human disease risk via pathogen dilution and increased food diversity.

Abstract: The universal principles of life such as DNA allowed biology to become an exact science. However, one of the universal principles of life is diversity, variation among living things made possible by writing different texts with the DNA-alphabet. Ecologists are fascinated by this variation, which they try to describe, order and explain. My own journey into biodiversity research began with a vegetation analysis in a wetland and the question, if plant communities could be more than the random assemblages of different species occurring in the same place postulated by Gleason. During postdocs in the UK and USA, I became a firm believer of the “Gleasonian” view. With the increasing concern about biodiversity loss from local to global scale I joined research programs where we asked what would happen if species would be removed from well-functioning plant communities. Indeed, simulated extinctions from such communities lowered ecosystem functioning and stability in most cases, indicating that even if they were random assemblages, communities could benefit from the diversity of species within them. The likely reason for this was that no species could by itself be so variable to take up all resources available in a locality. Thus, different species, which by chance differ in their abilities to take up resources, could complement each other in the task. However, when we compared this division of labor among species, we found that it was higher for species with a history of co-occurrence than in newly assembled communities. My view on the nature of plant communities is now switching back to a more “Clementsian” view, holding that they are more than random assemblages of species occurring in the same place. Rather it seems that multiple interactions among plants and with other trophic groups can be enhanced by evolutionary processes at the community level.

2. AWARD KEYNOTE

Beyond organic farming – harnessing biodiversity-friendly landscapes



Teja Tscharntke

Professor for Agroecology, Department of Crop Sciences, University of Göttingen, Germany

Teja Tscharntke has been Professor of Agroecology at the University of Göttingen since 1993. He studied sociology and biology in Marburg and Gießen, did his doctorate in Hamburg and habilitated in Karlsruhe. His research focuses on landscape perspectives on biodiversity patterns and associated ecosystem services of temperate and tropical regions, especially herbivory, biological pest control, pollination and quantitative food webs. There is also a strong interest in multidisciplinary studies integrating socio-economic and ecological analyses. He is editor of Basic and Applied Ecology (since 2000), "Highly Cited Researcher" on the Web of Science (since 2015) with an h-index of 137 (google scholar, 24.6.21) and has been honoured (2020) by the Royal Entomological Society (Award for Insect Conservation) and the British Ecological Society (Marsh Award for Ecology).

Abstract: We challenge the widespread appraisal that organic farming is the fundamental alternative to conventional farming for harnessing biodiversity in agricultural landscapes. Certification of organic production is largely restricted to banning synthetic agrochemicals, resulting in very limited benefits for biodiversity but high yield losses despite on-going intensification and specialization. In contrast, successful agricultural measures to enhance biodiversity include diversifying cropland and reducing field size, which can multiply biodiversity while sustaining high yields in both conventional and organic systems. Achieving a landscape-level mosaic of natural habitat patches and fine-grained cropland diversification in both conventional and organic agriculture is key for promoting large-scale biodiversity. This needs to be urgently acknowledged by policy makers for an agricultural paradigm shift.

The talk is based on a publication by Teja Tscharntke, Ingo Grass, Thomas C. Wanger, Catrin Westphal and Péter Batáry (2021) in: Trends in Ecology and Evolution (in press)

KEYNOTE

Soil ecology: Cornerstone science for transition

Gerlinde B. De Deyn

Professor for Soil Ecology at Wageningen University, Netherlands

I obtained my MSc in bio-engineering at Gent University (Belgium), and investigated biocontrol of root-feeding nematodes by soil-borne fungi. I discovered my passion for research and obtained a PhD degree at Utrecht University, focusing on the role of soil fauna in the restoration of grassland biodiversity. Thereafter I performed research in Canada, the UK and The Netherlands, with the goal to better understand the coupling between plant traits, plant diversity, soil biodiversity and soil functioning. My ultimate aim is to be able to predict from (remotely sensed) plant traits how nutrient cycling can be steered to achieve higher nutrient use efficiency and produce more nutritious crops, reduce greenhouse gas emissions from soil and suppress the build-up of pests and diseases. In 2011 I joined Wageningen University & Research to develop this research line further; in 2016 I was promoted to Professor in Soil Ecology.

Abstract: Soils are the fundament of terrestrial ecosystems, yet for a long time soil life and all the functions it performs remained largely hidden. During the last decades novel technologies enabled the discovery of the vast biodiversity that soils harbor as well as the processes they drive. The prediction of ecosystem functioning based on the taxonomic composition of soil life remains challenging. However, we do know that the interactions and feedbacks between soil life, plants and soil chemistry and physics are essential for soil and habitat formation, maintenance and restoration. Moreover, soil biota underpin the cycles of carbon and nutrients, thereby supporting the production of food, feed and fibre, and being key players in greenhouse gas balances. The current status of our soils globally is worrisome as due to a multitude of stressors soils are lost much more rapidly than that they are formed. Nevertheless, the recognition of the importance of healthy soils for enabling to achieve multiple sustainable development goals has put soil and soil ecology on the political agenda and triggered interest from many non-academic stakeholders. Clearly, soil ecology can contribute greatly to solving large societal issues, yet will require concerted action to bend the curve and create win-wins of soil and habitat conservation, regeneration and sustainable development.

KEYNOTE

The tail of application wagging the dog of knowledge: Is ecological science fit for policy?

Carsten Dormann

Professor for Biometry and Environmental System Analysis, University of Freiburg, Germany

Carsten Dormann studied Biology at the University of Kiel, Germany, and did his PhD in Plant Ecology at the University of Aberdeen, Scotland, on Climate Change effects in the Arctic. After a short PostDoc on invasive species in the Mediterranean, he held a PostDoc-position at the Helmholtz Centre for Environmental Research-UFZ, where he also got tenured after leading a research group on Biotic Ecosystem Services together with the Agroecology group in Göttingen. In 2011, he was appointed to a chair at the University of Freiburg, Germany. Having started as an experimental field botanist, his interests moved more and more into the statistical realm and most work over the last decades has covered methodological development and reviews, with a focus on species distribution analysis and interaction networks. Alongside, he harbours an interest in methods to bridge the gap between process models and observational data to advance ecological synthesis, and in questioning research findings with political implications.

Abstract: Ecological topics feature more and more at the science-policy interface. Biodiversity decline, loss of ecosystem functions, overexploitation of biological resources and alike lead to a demand for ecological statements. But is the advice that ecologists give sound, useful, correct? I suggest, and elaborate in this talk, that a lack of coherence in the science of Ecology leads to different ecologists giving different answers; to a dominance of advocacy over knowledge; to arguments from anecdotes rather than fundamental understanding. Taking a leaf from the book of other disciplines, particularly those involved in policy advice, such as law and economics, I suggest that there we need to take four concrete steps to make Ecology ripe for policy advise, and alongside use the hodgepodge of applied case studies to make applied ecology credible. To find out which four steps I have in mind, you will have to listen to the talk.

KEYNOTE

Citizen Science - Innovation potential for biodiversity research

Aletta Bonn

Chair of Ecosystem Services, Helmholtz-Centre for Environmental Research – UFZ, Friedrich Schiller University Jena, German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany

Aletta Bonn studied Biology at the Freie Universität Berlin, Bangor University (Wales) and the Technische Universität Braunschweig, where she also conducted her PhD on community ecology of carabid beetles and spiders in floodplains. She then spent 12 years working at the science-society interface with experience in conservation research and management at the University of Sheffield, the Peak District National Park and the International Union for Conservation of Nature (IUCN), UK. After return to Germany in 2012 and a research stay at the FU Berlin and the Helmholtz Centre for Environmental Research-UFZ, she was appointed Chair and Head of Ecosystem Services at UFZ and the Friedrich Schiller University Jena in the frame of the German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany, in 2014. Her research focuses on understanding the linkages between biodiversity and people in transdisciplinary joint working, especially with respect to biodiversity and ecosystem service change, biodiversity and health, as well as citizen science. Aletta is currently leading the development of the Citizen Science Strategy 2030 for Germany with a large consortium of university and non-university partners.

Abstract: Citizen Science, the involvement of volunteers in research, has a long tradition in ecology. In many cases, ecosystem research would not be possible without community expertise, and an estimated 80-90% of all species data are collected by volunteers. The prominent Krefeld Insect Survey has highlighted the importance of the engagement of taxonomic experts from natural history societies, environment NGOs, and single citizens in biodiversity science and policy. How can we foster this innovation potential of Citizen Science to collectively collate not only large-scale spatiotemporal datasets, but also ask exciting new questions? Or is citizen participation more of a media attention generator and nice-to-have? How can we develop quality controls and data infrastructures to encourage and support collaborative research? What added value can Citizen Science bring to lifelong learning for a deeper understanding of science and scientific literacy in a democratic society? To what extent does Citizen Science also provide a transformative contribution to self-efficacy and to counteracting the 'extinction of experience' of nature, both important pillars for nature conservation? And how can the shared fascination with nature of volunteers and academic scientists bring biodiversity research, policy and practice forward and feed into the process of developing the Citizen Science Strategy 2030 for Germany?

KEYNOTE

From small-scale processes to ecosystem transitions - a call for integrating simulation models into the ecologist's toolbox

Britta Tietjen

Chair of Theoretical Ecology, Freie Universität Berlin, Berlin, Germany

Britta Tietjen studied Applied System Science at the University of Osnabrück and went for her diploma thesis to the Environmental Research Centre (UFZ). She did her PhD on dryland vegetation ecology at the University of Potsdam and subsequently started a postdoctoral position on climate change impacts on ecosystems at the Potsdam Institute of Climate Impact Research (PIK). Soon after, she accepted a Juniorprofessorship on Biodiversity/Ecological Modelling at Freie Universität (FU) Berlin, Germany, and is now full professor of Theoretical Ecology at FU Berlin. Throughout her career, she has focused on how small-scale processes and biotic and abiotic interactions impact the properties and dynamics at the ecosystem level, using a variety of simulation-based modelling approaches. Her main interests are mechanisms and feedbacks that stabilize or destabilize the functioning of ecosystems under global change, and the role of biodiversity in this context. Here, a particular focus lies on water-stressed ecosystems, where she assesses, for example, the implications of land use transitions on biodiversity and ecosystem functioning, or the question of how particular species traits facilitate the long-term supply of different ecosystem services in restoration projects.

Abstract: Worldwide, climate change and maladapted land use cause degradation of ecosystems. This degradation has drastic consequences for species diversity, ecosystem functioning and the supply of services with strong implications for human well-being. Often, the transition towards a degraded state is not caused by a single factor. It rather emerges as a result of the complex interplay of several interacting factors and positive feedbacks within the ecosystem, leading to cascading effects. Examples can be found across ecosystems, such as soil erosion in drylands leading to further loss in vegetation cover, eutrophication of lakes or interactive effects of climate warming and pathogens in forests. Embracing this complexity requires a toolbox of methods that builds bridges between the understanding of local processes and emerging properties at larger scales. In my talk, I will use examples from dryland ecosystems to underpin that simulation models should be an integral part of this toolbox. They can guide our way of thinking about complex systems, enhance our understanding of how small-scale interactions between biotic and abiotic parts of ecosystems shape whole-ecosystem dynamics, and help to determine how changes in climate, land use or other drivers might trigger the transition to an undesired state. As part of an ecologist's toolbox, simulation models can therefore contribute to anticipating, preventing and even reversing undesired ecosystem transitions.

GfÖ Award Session

Science to practice: Cross-disciplinary approaches for sustainable agriculture

Bea Maas

Winner of the first GfÖ Award 2020

Sustainable land use development depends on multiple perspectives and interests. Achieving sustainability, however, requires collaboration across disciplines, or in short "cross-disciplinary" approaches. Multi-, inter- and transdisciplinary approaches are often used as synonyms, although they are defined by different levels of integrating results and perspectives. Using ecological, sociological and economic case studies on agricultural biodiversity and associated ecosystem services, this presentation will highlight challenges and opportunities related to cross-disciplinary approaches in agro-ecological science and practice.

SESSION 1

50 years Ecological Society of Germany, Austria and Switzerland – past, presence and future of ecology in a changing world

CHAIRS: ***Christian Ammer, Alexandra-Maria Klein***

The importance of the scientific discipline ecology has undoubtedly increased in the past 50 years and thus since the founding of the Ecological Society of Germany, Austria and Switzerland (GfÖ) in 1970. In the face of species extinction and climate change, ecology has even become a key discipline for the long-term survival not only of many species, but ultimately also of humans. Nevertheless, we experience that the voice of ecologists working scientifically only enters politics to a limited extent and often fails setting the impulses that are indispensable for a nature-compatible and sustainable resource-use. Against this background, we will look back to the history of ecology over the past 50 years[1], and thus also that of the GfÖ, and subsequently discuss[2] how ecologists, but also how a scientific society, can participate in societal discussions. Based on an active role in such discussion, the GfÖ may contribute, in concert with other scientific societies, to enforce evidence-based argumentation the priority over perceived truths that it deserves by political decision-makers.

[1] Presentation by Wolfgang Haber, founding member and long-time president of the GfÖ, professor emeritus for landscape ecology at the TU München

[2] Panel discussion by Josef Settele (Head of the Department of Conservation Biology & Social-Ecological Systems Helmholtz-Centre for Environmental Research – UFZ) and Markus Fischer (Institute of Plant Sciences, University of Bern). The two panellists hold a variety of high-ranking positions in various advisory boards in the science-policy interface.

SESSION 2

Biodiversity and Ecosystem Services in Agricultural Systems: Field to Landscape-Scale Management for Biodiversity-Yield Synergies

CHAIRS: ***Catrin Westphal, Annika Hass, María Felipe-Lucia, Maria Kernecker***

Land use change and agricultural intensification are considered major drivers of biodiversity loss and can impair ecosystem functions and services in agricultural landscapes. At the same time, agricultural production relies on vital agroecosystems and species providing important ecosystem services, such as decomposition, biological pest control and pollination. Hence, we need innovative production systems that sustain agrobiodiversity and promote ecosystem services (e.g. ecological intensification). Moreover, managing agricultural landscapes for heterogeneity could likewise enhance both agricultural production and agrobiodiversity. This would, however, require collaboration between multiple farms and other land use systems. Despite the abundance of ecological studies showing the importance of coherent landscape-scale management for biodiversity, most policies and instruments (e.g. agri-environmental schemes) only target single fields and farms. In this session, we will focus on different approaches and measures that target the diversification of cropping systems and conservation of functionally relevant species and the ecosystem services they provide. This session will provide insights in the ecological but also socio-ecological outcomes of a wide range of local to landscape scale measures. For instance, benefits (and costs) of intercropping, mixed-cropping and reductions in agrochemical inputs as well as farm level (e.g. organic agriculture) and/or landscape level (e.g. hedgerows, flower-strips) measures. We also aim to identify cases in which individual or collaborative management is needed for biodiversity-yield synergies either in-field or across defined landscapes (e.g. via spill-overs between fields or land-use systems). At a broader level, our session aims to contribute to a less conflicted discourse between agricultural production and biodiversity conservation.

02-O-01 - The science, the policy and reality: where are the win-wins for farmers and the environment, and what will the next CAP do to support them?

Guy Peer[1,2], Maren Birkenstock[3], Sebastian Lakner[4], Norbert Röder[3]

[1]*German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE*
[2]*Helmholtz Centre for Environmental Research - UFZ, Leipzig, DE*
[3]*Thünen Institute of Rural Studies, Braunschweig, DE*
[4]*University of Rostock, Rostock, DE*

The EU's Common Agricultural Policy (CAP) has so far failed to halt the loss of farmland biodiversity, reduce agricultural greenhouse gas emissions, or halt the loss of farming employment. More than 3600 scientists called to improve the CAP's performance for the benefits of people and nature, and over 300 scientists, from 22 Member States, provided their expertise (through 13 workshops and a follow up online survey) helped developing recommendations on how to improve the CAP's performance for biodiversity (and climate). Six key issues emerged as crucial for the success of the CAP's Green Architecture: a) protection and restoration of landscape features and semi-natural areas, including grasslands, b) a need to prioritize on habitat diversity and multifunctionality, c) spatial planning in target-setting and implementation, d) collaborative and result-based approaches to increase effectiveness and efficiency, e) implementing result-based approaches, and f) placing significant investment in communication, education and farmer engagement.

In parallel, negotiations over the CAP reform were characterized by immense resistance to changing the policy, with particular tension around environmental ambition. Collaborative implementation, or the so-called "Dutch model", seemed to be one exception, perhaps pointing at a path of least resistance. Nonetheless, (as of yet) neither the CAP's legal texts nor the German implementation plan adopt this approach or promote it explicitly, at least not at the national or EU levels. In light of a deep policy failure, can bottom-up processes help scaling up good practices to the extent needed?

02-O-02 - Factors driving farmland biodiversity at the landscape scale

Eliane Meier[1], Gisela Lüscher[1], Eva Knop[1]

[1]Agroscope, Zurich, CH

Aim: Farmland biodiversity is still declining. Up to date most of what we know regarding factors that drive farmland biodiversity is based on studies analyzing patch-scale diversity. Here, we therefore aimed to disentangle the impact of direct and indirect, local and landscape scale environmental (i.e. abiotic and land-use) factors on farmland biodiversity at the landscape scale.

Methods: We used a large data set on plants, butterflies and birds collected in 123 investigation squares (i.e. entire farmland within 1 km^2), evenly distributed over a large gradient of environmental conditions in Switzerland. Abiotic conditions were quantified by variables related to topography and climate, whereas land-use was quantified by variables related to land-use intensity and landscape heterogeneity. Using structural equation models, we estimated the direct and indirect effect of these variables on landscape-scale multitrophic species richness (MSR) and, for a more mechanistic understanding, on the share of different trait groups.

Results: In addition to abiotic conditions, high land-use intensity had a direct negative effect on MSR. It had further a negative effect on landscape heterogeneity, which also translated into a negative effect on MSR. Accordingly, a large diversity of different habitat types managed at low intensity counteracted the negative effect of high land-use intensity on MSR. Interestingly, we found few effects of landscape-scale factors on the share of specific traits, but rather of local-scale management.

Conclusions: To stop the ongoing loss of farmland biodiversity at a larger scale, it is important to optimize both, the effectiveness of direct as well as indirect effects of low-intensity management.

02-O-03 - Tree-based restoration - islands of diversity in a sea of oil palms

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Oil-palm plantations can promote the wellbeing of smallholder farmers but this usually comes at the expense of declining biodiversity and ecosystem services in tropical regions. In Indonesia the conversion of forests into large-scale oil-palm plantations represents a major threat to biodiversity and the provisioning of ecosystem services. One approach to alleviate biodiversity loss within oil-palm plantations could be planting tree islands that facilitate natural regeneration, the recovery of ecosystem complexity and benefit associated biodiversity. Here, we ask if enriching oil-palm plantations with native trees promotes the natural restoration of biodiversity and ecosystem functioning and how this trades-off with oil-palm yield. To answer this question, a large-scale Biodiversity Enrichment Experiment (EFForTS-BEE) was established in Indonesia, Sumatra. In total, 52 tree islands varying in size (25 m^2, 100 m^2, 400 m^2, 1600 m^2), richness of native trees (0, 1, 2, 3, 6) and species composition were established within a traditional oil-palm plantation. In addition, four control plots were established within management-as-usual oil-palm monocultures. In comparison to oil-palm monocultures, tree islands promoted higher multi-taxa diversity above- and below-ground while also improving important ecosystem properties and functions, such as soil fertility, higher vegetation structural complexity, and soil water infiltration. Tree islands promoted natural regeneration where taxonomic and phylogenetic diversity of spontaneous trees increased with island size and diversity. Performance and growth of planted trees increased with tree species richness while overall oil-palm yield (spillover effect excluded) decreases with island diversity. Thus, long-term tree-palm competition and potential trade-offs between the recovery of ecosystem multifunctionality and oil-palm productivity still needs further investigation. In conclusion, creating islands of diversity in mono-specific oil palm landscapes might be a promising strategy to restore some aspects of biodiversity and ecosystem functioning without compromising smallholder farmers' income and livelihood.

02-O-04 - High crop yields without biodiversity loss in tropical agroforestry

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Resolving ecological-economic trade-offs between biodiversity and agricultural profits is of great importance to alleviate the current biodiversity crisis. Here, we focused on smallholder vanilla agroforests in northeastern Madagascar, a global biodiversity hotspot. Agroforests established in thinned forests supported 30 % (48 %) less (endemic) species than old-growth forests, whereas agroforests established on fallows had 26 % (132 %) more than fallows. Vanilla yields varied by more than two orders of magnitude, but were not related to richness of trees, herbs, birds, amphibians, reptiles, or ants. While yields increased with more and longer vanilla vines, non-yield related management variables such as canopy closure and landscape forest cover largely determined biodiversity. Hence, win-win solutions combining high yields with high biodiversity can be achieved by complementary management. In conclusion, vanilla yields were unrelated to biodiversity losses, opening up possibilities for sustainable conservation outside of protected areas and restoring degraded land to benefit farmers and biodiversity alike.

02-O-05 - Low-intensity land-use enhances soil microbial activity, biomass, and fungal-to-bacterial ratio in current and future climates

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Progressing climate change and intensified land-use exert unprecedented pressures on soil microbial communities, thus endangering the essential ecosystem functions they provide. However, these global change factors do not act in isolation from each other, making ecosystem consequences hard to predict. To address this knowledge gap, we tested the interactive effects of climate change and land-use intensity on soil microbial activity, biomass, and community composition in a large-scale field experiment. We tested soil microbial responses to a future climate scenario (ambient climate *versus* increased temperature by +0.6°C and altered rainfall patterns) in two land-use types (cropland *versus* grassland) with two levels of land-use intensity each (high-intensity *versus* low-intensity). While high-intensity land-use is characterized by fertilization and pesticide use, low-intensity land-use refrains from both and is distinguished by higher plant diversity. We measured soil microbial activity and biomass twice per year within a 5-year period and used phospholipid fatty acid analysis to explore changes in microbial community composition. In contrast to our expectations, soil microbes remained largely unaffected by future climate conditions. However, we found evidence that not just the type of land-use, but also their respective management intensity (high *versus* low) had strong effects on soil microbes. Low-intensity management promoted soil microbial activity and biomass in grasslands, but this beneficial effect needed time to establish. Moreover, we show that low-intensity management increased AM fungi and fungal-to-bacterial ratios in croplands as well as grasslands. Given the widely-known importance of soil microbial biomass and enhanced fungal-to-bacterial ratios, we conclude that low-intensity management can have beneficial effects for efficient carbon storage, nutrient cycling, soil erosion control, and ecosystem multifunctionality across land-use treatments and climate-change scenarios. At the same time, slowly changing soil properties emphasize the need for long-term studies on interactive global change effects to sustainably safeguard healthy soils in the future.

02-O-06 - Ecosystem functions of rare arable plants

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Rare arable plants are suffering from agricultural intensification in European farmlands. Better knowledge of the ecosystem functions of these primary producers could prove the nature conservation value and provide integrative recommendations for biodiversity management in agricultural landscapes. Here, we aim to identify the following ecosystem functions of rare arable plants: their contribution to phytodiversity; their impact on soil fertility and nutrient cycling, on productivity, on flower visiting wild bees, biological control potential and on human perception of nature. Our experiments were performed in the Munich plain where an experimental field and a field study on ten farms were installed. Ten species of rare arable plants were sown at varying crop densities. Furthermore, the performance of rare arable plants was also compared to wildflower strips which are commonly used in agri-environmental schemes to increase farmland biodiversity. Our results show that some ecosystem functions (phytodiversity and human perception of nature) can be generally improved by sowing of rare arable plants in combination with cereals. For other functions (soil fertility and nutrient cycling, productivity, flower visiting wild bees and biological control), the sowing of rare arable plants did not show immediate measurable effects when sown with crops. Pure sowing of rare arable plants performed just as well as wildflower strips for some measured ecosystem functions (flower visiting wild bees, biomass production and human perception of nature). Our study showed that sowing of rare arable plants can significantly improve multifunctionality. Organisms of higher trophic levels may require longer-term investigations to detect such effects. This study provides opportunities for both conservation of rare arable plants and also improving the functioning of agro-ecosystems.

02-O-07 - Simulation of resistance to dispersal of arthropods and plants in an agricultural landscape

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Agricultural intensification has led to the fragmentation and destruction of habitats. This has a negative effect on the species adapted to the former cultural landscape. When habitats are sparse, landscape connectivity becomes more important, because it allows the colonisation of remaining habitats. Conserving or restoring landscape connectivity can thus be a successful protective measure, but these measures have to be guided by a solid knowledge about the relevant species and their interaction with the landscape. This knowledge can be deepened by the use of landscape connectivity models. Generating such models is a complex process, in which the creation of a resistance surface is especially challenging. A resistance surface represents the landscape as it is perceived by the relevant species in terms of facilitation or impediment to movement. For generating such a resistance surface, we apply the R package ResitanceGA. While it was originally created to calculate resistance surfaces using genetic distances within the landscape it can also handle other distance measures such as the Jaccard distance. In order to understand connectivity for a set of species in an agricultural landscape, we identified the occurring species of spiders, carabids, and vascular plants at 64 different spots in the surroundings of Münster, Germany. These arthropods and plants were then assigned into different categories regarding their dispersal behaviour. Jaccard distances were calculated to act as input data for ResistanceGA to generate the resistance surfaces for the different categories regarding dispersal behaviour. With the help of these resistance surfaces, we will identify landscape elements playing a major role for the conservation of landscape connectivity for spiders, carabids, and vascular plants and quantify their contribution to connectivity.

02-O-08 - Pre-alpine rice paddies – A promising strategy to conserve a subset community of natural wetland aquatic macroinvertebrates on the Swiss plateau

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Natural wetland areas are declining globally because of increased demand for agricultural output, but little is known about whether rice paddies north of the Alps could serve as a possible solution to reconcile the restoration and conservation of wetlands with the agricultural situation. We conducted a comparative study to assess diversity patterns, in particular abundance, α- and β-diversity, of aquatic macroinvertebrate communities, the abiotic factors that drive these patterns, and the ecosystem functions resulting from them in rice paddies and natural wetlands on the Swiss plateau. Macroinvertebrates were sampled and analyzed from 13 rice and 13 permanent natural wetland plots from four time points, four geographical regions and two different historical backgrounds ("old" and "young"). Averaged linear mixed-effect models revealed lower family richness but similar abundance of aquatic macroinvertebrates in rice paddies compared to natural wetlands. The overall beta dissimilarity between rice and natural wetland plots, which was significantly higher than for within treatment comparisons, was found to be mainly caused by communities in rice fields being a subset of natural wetlands, rather than resulting from unique sets of families. Water nutrients showed opposing effects on diversity, with a negative effect on richness but a positive effect on abundance and in addition was found to only have an effect on the beta dissimilarity component resulting from filtering of communities. Ecosystem functions, namely dragonfly- and damselfly conservation and mosquito control, were performed equally well by treatments, with even higher abundances and species richness of dragonfly- and damselflies and lower mosquito larvae abundances in rice paddies. These results suggest that rice paddies north of the Alps can be a strategy to conserve a subset community of natural wetland aquatic macroinvertebrates and that management strategies could be adjusted to further enhance biodiversity.

02-O-09 - Supporting biological pest control with different agri-environment schemes

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Agricultural intensification has led to a dramatic loss of species and associated ecosystem services over the past centuries. Agri-environment schemes (AES) have been developed to react to the challenges caused by agricultural intensification and to promote biodiversity. There are two of the most popular agri-environment schemes strategies: organic farming and flower strips. Organic farming focuses on production and conservation on the same land-use area, whereas flower strips adjacent to crop fields are in favour of intensified conventional production combined with conservation strips outside the cultivated area. We investigated pest and natural enemy abundances of organic farming vs. establishing flower strip in ten agricultural landscapes in Central Germany along a gradient of mean field size (1.24 - 6.78 ha). We focused on three winter wheat fields per landscape: conventional field (control), conventional field with adjacent flower strip and organic field. We sampled crop pests such as cereal leaf beetles (CLB) and cereal aphids as well as their natural enemies. Our results indicate that the abundance of CLB larvae was more than two times higher in conventional farming with and without flower strip than in organic farming. The abundance of natural enemies was supported by landscapes with small mean field size. Aphid abundance was lower in organic fields and conventional control fields than in conventional fields with flower strips suggesting a potential disservice of flower strips. Parasitoids and natural enemies benefited from flower strips, but they were obviously not able to control the aphids. Our study concludes that organic farming, flower strip and small field sizes are all promising measures to reduce crop pests. In the future, these three measures would not be implemented separately, but combined to enhance the natural enemy populations and facilitate the biological control of the main crop pests.

02-O-10 - Influence of local management and landscape composition on predatory mite populations in three different European wine-growing regions

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Viticultural practices (e.g. pesticide use, cover crops) and landscape composition are major factors influencing ecosystem services and biodiversity dynamics in vineyard landscapes. In this context, identifying management options to support predatory mites (Phytoseiidae) as natural enemies of harmful spider mites (Tetranychidae) and gall mites (Eriophyidae) is crucial for their sustainable control.
The effects of farming systems (organic/integrated/conventional), cover type in the inter-row (species rich/species poor cover crops/spontaneous vegetation) and landscape composition (gradients of high and low cover of vineyards and semi-natural habitats within a 500 m buffer) on the density of predatory mites in the vine canopy was evaluated in this study. To this end, mites were sampled at four different dates in 36 vineyards from the Bordeaux region in France, 32 vineyards in the Palatinate region in Germany and 32 vineyards in the Leithaberg region in Austria.
Preliminary results showed that in the Leithaberg region, predatory mite densities were promoted by integrated management, spontaneous vegetation cover in the inter-row and higher cover of vineyards at the landscape scale. Low predatory mite densities in Bordeaux were influenced by the farming system where conventional vineyards showed slightly higher densities than organic vineyards. In the Palatinate region, all vineyards were organically managed, and the predatory mite densities were neither influenced by the inter-row cover type nor by the surrounding landscape composition.
Overall, predatory mite populations in vineyards were mainly influenced through different management types, whereby less fungicide and insecticide applications were beneficial. High predatory mite densities in the Leithaberg region benefited from spontaneous vegetation and surrounding vineyards probably due to better food provision with pollen and possible dispersal effects of the mites between vineyards.

02-O-11 - Maintaining steep slope viticulture for spider diversity

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Viticulture on steep slopes has shaped both, landscape and biodiversity in Germany´s winegrowing regions such as the Upper Middle Rhine Valley (UMRV) for centuries. However, in recent years, vinicultural area on steep slopes declined strongly due to insufficient profitability and the many fallow vineyards clearly reflect this development. One approach to keep management economically viable and thereby halt the decline of viticulture is modern vineyard terracing. Here, vineyard rows run parallel to the hillside, thus facilitating management. At the same time, terrace embankments offer large non-cropped areas between the grape vines that could make a significant contribution to biodiversity. However, little is known about the effects of these vineyard types on biodiversity. We determined the effects of vineyard management types (terraced vs. vertically planted) in contrast to vineyard fallows, local habitat characteristics and the surrounding landscape on ground-dwelling spiders (Arachnida: Araneae) in 45 study sites along the UMRV in Germany. A diverse landscape mosaic of vineyard fallows, forests and vineyards created heterogeneity and contributed to a high species diversity irrespective of the vineyard type. Vineyard fallows supported communities distinct from managed sites as well as rare species. On managed sites and on terraced vineyards in particular, many xerophilic species and ant eating specialists prevailed. We conclude that management in steep slope viticulture is crucial to maintain open habitat structures and conserve associated spider species. Still, preserving vineyard fallows and overall landscape heterogeneity remains important to maintain a diverse spider community.

02-O-12 - Novel vineyard design boosts wild bee and butterfly diversity and abundance

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Future design of agricultural ecosystems needs to address insect conservation to halt the on-going loss of biodiversity. This is particularly important for steep-slope viticulture established at sites of high biodiversity potential. Therefore, we compared novel and conventional vineyard designs (cross-slope with greened embankments vs. down-slope or other types without greened embankments) using wild bees and butterflies as indicators for biodiversity in the lower Moselle region (SW Germany). Species richness and abundance in both studied groups is significantly higher in the novel compared to the conventional vineyard design. This difference also holds true for the number of specialised and endangered species. Additionally, the coenoses of wild bees and butterflies differed between both vineyard designs. Our findings underline that steep-slope vineyard design has major impact on biodiversity conservation. Since the cultivation of cross-slope vineyards on steep slopes has economic advantages over down-slope vineyards, we assume a great synergistic potential to reconcile agricultural use, biodiversity conservation and landscape planning.

02-O-13 - Local and landscape effects of agri-environment schemes and crops on pollen collection of bumble bees in agricultural landscapes

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Bumblebees provide important pollination services for wild plants and crops in agricultural landscapes. However, the loss of floral resources due to agricultural intensification is a major threat for bumblebee populations. Therefore, it is essential to identify local and landscape factors including agri-environment schemes that affect food resource availability and their impact on bumblebee colony growth and reproduction. In a first study we collected pollen from bumble bees foraging in different flower field types. In pollen samples from perennial flower fields we found partly lower plant species richness and a lower proportion of sown plant species compared to annual flower fields indicating lower foraging habitat quality. However, in all flower field types the proportion of sown plant species in pollen samples was surprisingly low demonstrating the importance of other landscape scale resources. In a second experiment we studied landscape scale effects of crop heterogeneity on bumblebee colonies and found that increasing maize cultivation reduced pollen diversity collected. Therefore, maize grown over large areas affected bumblebees negatively, as high pollen diversity promoted colony growth. Similarly, pollen richness had a positive effect on queen production of bumblebee colonies in a third experiment. Moreover, we found that parasitism by the wax moth had detrimental effects on colony growth, but decreased with higher proportions of semi-natural habitat in landscapes. Overall, the results of our studies demonstrate the importance of landscape scale resources which can be reduced by the expansion of intensively managed crops and might also affect parasitism of bumblebees. Agri-environment schemes like flower fields can provide important resources, but other semi-natural habitat types at the landscape scale remain crucial for promoting bumblebees and their essential pollination services in agro-ecosystems.

02-O-14 - Mass-flowering crop effects on pollinator densities, pollinator behavior and pollination services

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The availability of floral resources is a key driver of wild bee densities and diversity in agricultural landscapes. Mass-flowering crops can provide temporary food resources for pollinators which in turn are needed for crop pollination. We investigated how morphologically different mass-flowering crops, mass-flowering crop cultivation history, semi-natural habitats and landscape diversity affect different functional groups of bee pollinators at landscape scale, bee densities in crop fields as well as their pollination services.
At landscape scale, faba bean cultivation increased bumblebee densities in field margins and semi-natural habitats, while high oilseed rape covers increased the proportion of solitary bees. A high landscape diversity enhanced wild bee species richness. Bumblebee densities in faba bean fields were enhanced by high land covers of faba bean and semi-natural habitats, which in turn positively affected faba bean yields. Moreover, faba bean land cover modulated the foraging behavior of bumblebees in bean fields. In contrast, high oilseed rape land covers decreased bumblebee densities in co-flowering oilseed rape and later flowering faba bean with negative effects on faba bean yield. Further, high mass-flowering crop covers in the past three years positively affected wild bee densities in oilseed rape fields, contrasting the effect of current oilseed rape covers and unlike the response of honeybees.
We found that mass-flowering crops promote functional bee groups adapted to their flower structure and that landscape composition moderates bee densities and bees` foraging behavior in crop fields. We conclude that there is a need for more diverse landscapes that comprise morphologically different mass-flowering crops, promoting different functional groups of wild bees, combined with a high quantity and quality of semi-natural habitats to conserve diverse pollinator communities and to sustain high crop yields.

02-O-15 - Ecological intensification through integrated pollination management in macadamia orchards

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As the demand for agricultural products is increasing, a more efficient agriculture is needed to reduce external inputs and land degradation. To examine options for ecological intensification in a highly intensive managed and insect pollinated crop (Macadamia Integrifolia), we established a pollination experiment (open and hand pollination, pollinator exclusion) and pollinator observations in 10 South African macadamia orchards that differed in farm management (irrigation, number of varieties, managed bee colonies), altitude and landscape factors (cover of semi-natural pollinator habitat). We compared these influences based on their statistical relative importance.

The main insect pollinators of macadamia were managed and wild honeybees (Apis mellifera), which made up 95 % of all flower visitor individuals. Visitation rates increased with cover of natural or semi-natural habitat in the surrounding landscape (1 km radius), but not with the number of managed honeybee colonies in the surroundings of 1 km. We found that insect pollinators were crucial for a high nut set (127 % increase of initial nut set, 287 % increase of final nut set). Moreover, the nut set was determined by visitation rates and a high number of macadamia varieties in the orchard block. Further, the final nut set increased in trees close to the orchard edge with semi-natural habitat compared to trees in 50 m distance to the orchard edge. In contrast, irrigation and managed honeybee colonies played a minor role.

Pollination service is essential for macadamia nut production and can be enhanced by natural and semi-natural habitat on farm and landscape scale. Comparing the importance of different influences, semi-natural habitat and pollinators are equally or even more important to boost nut set than agricultural input. Ecological intensification through promotion of natural pollinator populations instead of conventional intensification is a viable option for more sustainable macadamia production.

02-O-16 - Impact of policy-induced changes in fallow land area on farmland bird populations

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Fallow land provides seed and invertebrate food, shelter and nesting sites for farmland birds and is crucial for the maintenance of farmland biodiversity in agricultural landscapes. In Europe, the Common Agricultural Policy (CAP) is a major driver of change in fallow land area. Since its introduction, the CAP has undergone successive reforms. Following the abolishment of compulsory set-aside in 2007, fallow land area declined sharply and increased again, but to a lesser extent, after the last CAP reform in 2014. To test the impact of changing fallow land area on farmland bird richness and population abundance across Germany, we combined data on fallows at the district scale covering three different agricultural censuses in Germany (2007, 2010 and 2016) with monitoring data on farmland birds. We hypothesized that the impact of changing fallow land area is especially strong for those species using fallows as breeding habitat and that the structural complexity of the landscape modulates the effect of fallow land. The results revealed a positive effect of fallow land on farmland bird species richness and abundance of bird species breeding in or at the edges of fallows. Contrary to our expectation landscape complexity only marginally modulated the effect of fallow land on bird species breeding in fallows and did not modulate the effect of fallow land for farmland bird species richness. Our results suggest that a more substantial promotion of non-productive areas (such as fallows) in agricultural landscapes within the post-2020 CAP could be an effective way to retard or even reverse further losses in farmland bird diversity and populations.

02-O-17 - Interactions between the world´s crane species (Gruidae) and the agricultural sector

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Crop damage created by wildlife requires careful collaborative management to transform ecosystem disservices into biodiversity-yield synergies. The numbers of common cranes (Grus grus) and sandhill cranes (Grus canadensis) have increased more than threefold in the last 40 years leading to higher incidences of crane foraging on newly sown seeds, with high economic costs to farmers. To synthesize knowledge of the bilateral effects of land use changes and populations and behaviour of the world´s 15 crane species, we conducted a systematic literature review of peer-reviewed publications on agriculture-crane interactions (n = 135) and on the importance of agricultural crops in the diet of cranes (n = 81). A conceptual framework analysis identified two major pathways in agriculture-crane interactions: 1) habitat loss with negative effects on crane species dependent on specific habitats and 2) expanding agricultural habitats with superabundant food availability beneficial for opportunistic crane species. Our results indicate that the degree to which crane species are able to adapt to agricultural land use changes may be an important factor explaining their population response. Reconciliation of crane conservation and agricultural production needs to be implemented from the local to the flyway-scale. By using a combination of scaring and diversionary fields, crop damage can be effectively prevented at the local scale. However, to assure long-term sustainability, effects of agricultural land-use changes and the establishment of protected areas on crane migration pattern and population development need to be addressed and managed at flyway- scale. Farmer acceptance for cranes and conservation initiatives in general is dependent on possibilities for stakeholder participation as much as on effective crop damage prevention.

02-P-01 - How do different organic fertilizers affect edaphic diversity?

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In recent decades, biodiversity in agro-ecosystems has declined in various species groups, some of them providing important ecosystem services. Intensive agricultural practices such as pesticide use are known to exert a negative impact on biodiversity, in particular on arthropods. In contrast, little is known about fertilisation practices on soil meso- and macrofauna. In the DüNaMed project funded by the German Federal Office for Nature Protection, we analyse the effect of different types of organic and mineral fertilizers (a.o. cattle manure and slurry, straw, residues from biogas plants, compost) on edaphic diversity in field trials on two sites. To obtain a comprehensive view on a wide range of taxonomic groups, we use three different sampling methods: pitfall traps for epigeic organisms, emergence traps to collect soil-dwelling organisms, soil extractions with Berlese funnels to extract hypogeic organisms, and finally the analysis of eDNA (environmental DNA). Results are expected to assess the relevance of fertilizer management for the maintenance of edaphic diversity.

02-P-02 - Lasting decrease in functionality and richness: Effects of ivermectin use on dung beetle communities

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Use of ivermectin in agro-ecosystems negatively affects non-target dung beetles, which provide keystone services for pasture functioning. While the direct effects of ivermectin residues on dung beetles are at the center of scientific attention, its long-lasting effects on routinely treated pastures are unknown for real communities.

We studied basic characteristics (species richness, abundance, biomass) and functionality (dung removal ability represented by guild composition) of dung beetle communities in response to routine ivermectin treatment on 15 treated and 11 untreated sites, covering seasonal variability and four herbivore dung types across the Czech Republic. We split the samples into three categories, i) never treated, ii) recently treated (<8 weeks post-treatment, lethal or sublethal levels of residue), and iii) long-ago treated (>8 weeks, sublethal or inconsequential levels of residue). Recorded species were classified into three guilds, i) relocator (all stages coprophagous, high dung removal ability), ii) dweller (all stages coprophagous, medium dung removal ability), and iii) visitor (coprophagous adults, saprophagous larvae, low dung removal ability).

Per pat abundance on recently treated sites was reduced by 32 %, species richness by 37 % and functionality by 64 % compared to non-treated sites. Similarly, per pat abundance on long-ago treated sites was reduced by 36 %, species richness by 29 % and functionality by 44 %. Total biomass did not significantly change, however, ivermectin use decreased the biomass of beetles with high contribution to dung removal (relocators and dwellers), while the biomass of beetles with low contribution (visitors) remained unaffected.

Our results highlight that the effects of ivermectin use on biodiversity and ecosystem functioning last far beyond its physical presence in the grazing system. Therefore, all precautions should be taken to avoid such negative effects on non-target organisms.

02-P-03 - Artificial nesting hills support wild bees in the agricultural landscape

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Wild bees are declining due to the loss of habitats, floral resources and other anthropogenic influences. Wide ecological and economical interest evolved to preserve wild bees and their pollination service. An increasing number of projects have focused on the establishment of flowering strips to improve feeding options for wild bees in agricultural landscapes, however, bees also depend on non-floral resources, particularly on adequate nesting resources. The aim of this investigation was to evaluate whether artificial nesting hills can act as a supplementary nesting habitat for wild bees. The study was embedded in the long-term project BienABest (www.bienabest.de), that aims to increase wild bee diversity and to secure the ecosystem service of pollination. We explored wild bee communities at newly established nesting hills in 20 regions across Germany for two consecutive years and determined how different abiotic parameters influenced wild bee activity. We were able to show that artificial nesting structures can act as a valuable nesting resource for a great spectrum of bee species. Species richness and abundance increased from the first to the second year and the activity of bees was highly influenced by the temperature. We conclude that locally available soil, sun exposure and existence for multiple years are important factors for a successful colonization by wild bees.

SESSION 3

Improving Biodiversity Monitoring in Terrestrial Ecosystems

CHAIRS: ***David Ott, Christoph Scherber, Hannah Reininghaus, Michael Meyer, Vera Zizka***

The aim of this session is to showcase and discuss current approaches to biodiversity monitoring in different countries and generate ideas for improvement. Ideally, a question- and hypothesis- driven approach to monitoring of biodiversity, ecosystem processes and environmental drivers is developed, combined with experimental manipulation of selected drivers.

03-O-01 - National monitoring center of biodiversity

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In the end of March 2021, the National Monitoring Center of Biodiversity was officially established with the overarching goal to enhance and further develop nationwide biodiversity monitoring in Germany. We will give an overview of its main tasks and structures as well as current and future actions.

03-O-02 - Monitoring 6000 habitats of national importance in Switzerland: the first 10 years

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Switzerland has inventoried dry meadows and pastures, alluvial areas, bogs and fens, and amphibian breeding sites. The most valuable of these sites are considered to be of national importance and are protected by law. These sites of national importance are the cornerstones of the Swiss ecological infrastructure and are prime habitats for a multitude of specialist, rare and threatened species.

In 2011, a long-term monitoring project "Monitoring the Effectiveness of Habitat Conservation in Switzerland" has been initiated to inform the Swiss government about the development of the sites of national importance, i.e., to report on changes in their state. This presentation focuses on vegetation surveys regularly conducted at these sites and on the indicators developed to report on changes. It will also discuss major challenges and data gaps, which complicate the interpretation of changes in vegetation.

03-O-03 - The SASSCAL observation net in southern Africa – first results of time-series analyses of 19 years of annual vegetation monitoring

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The megadiverse southern African subcontinent is subject to severe biodiversity loss. Anthropogenic habitat transformation, land-use intensification and climate change are major drivers. Extent and rate of the biodiversity loss as well as the respective effects of the environmental drivers on the various vegetation types with their specific species and trait composition are still poorly understood. The SASSCAL network of standardised biodiversity observatories (www.SASSCALobservationNet.org) addresses these knowledge gaps. The Observation Net comprises 65 biodiversity observatories of a standardised design spread across Angola, Namibia, western Zambia, and western South Africa, describing a subcontinental climatic gradient ranging from arid winter rainfall to subtropical summer rainfall regions, representing different levels of land-use intensities. Each observatory is 1 km² in size and subdivided into a grid of 100 hectares. Since 2001, we annually assess the vegetation at species level in a nested design of 100 m² and 1000 m² plots in the centre of 20 randomly selected hectares. Automatic weather stations adjacent to the observatories record the weather condition in hourly intervals (www.SASSCALweathernet.org).
After a brief introduction to the concept and design of the SASSCAL Observation Net we will present findings from two observatories representing different biomes of southern Africa. The time-series analyses based on 19 years of annually assessed vegetation data will reveal the vegetation dynamics as well as the relative effects of land-use intensity and interannual patterns of seasonal weather conditions as environmental drivers. These two example observatories will showcase the potential of the long-term monitoring data and demonstrate the value of standardised long-term biodiversity monitoring in the region.

03-O-04 - Standardized nesting aids as sampling method for monitoring cavity nesting wild bees in agricultural landscapes

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Wild bees are important pollinators for numerous wild and crop plant species. Despite their importance for agricultural purposes, the state of wild bees is assessed as critical. Moreover, comprehensive, representative databases on the status and the development of wild bee populations, especially in relation to land-use, are still lacking. To tackle this issue, we design in the joint project MonViA a wild bee monitoring in agricultural landscapes. Our main objectives are among others to develop standardized methods that (i) are non-lethal and allow in addition (ii) to assess the spatio-temporal use of food resources of wild bees in agricultural landscapes and (iii) volunteers to take part in monitoring activities.
For recording cavity nesting wild bee species, we designed a standardized nesting aid with regard to size and ratio of offered cavity diameters along a landscape gradient ranging from homogeneous to heterogeneous agricultural landscapes in Saxony-Anhalt. Using species diversity and occupancy as response variables, we tested three different sizes of nesting aids varying in the number of offered nesting boards and four different ratios of cavity diameters that were nested in size. Nesting aids were set up in agricultural landscapes scattered across Saxony-Anhalt.
We modeled (among others) the probability of occupancy of wild bee individuals as a function of size of nesting aids and ratio of offered cavity diameters and entered landscape parameters as interaction terms on the GLMMs. Preliminary results showed that beside landscape parameters (landscape structure, presence of protected areas) the size of nesting aids had the largest significant positive effect on the number of wild bee individuals.
The prototype of the so far standardized nesting aid is currently tested at further sites across Germany. In a nationwide trial, we develop and test together with more than 80 volunteers how volunteers can be involved in recording and identifying cavity nesting wild bee species for future monitoring activities.

03-O-05 - DNA metabarcoding in large-scale insect diversity monitoring

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DNA metabarcoding is a promising tool for biodiversity monitoring, enabling the fast and high-resolution identification of insect communities from bulk samples. The method is based on the DNA extraction and simultaneous barcode amplification from samples containing a mixture of taxa and potentially also enables the analysis of intraspecific genetic diversity. Compared to morphological determination, sample identification through DNA metabarcoding is largely decoupled from taxonomic expertise. This fast and cost-efficient approach enables taxonomic assignment of species hard to identify morphologically if those are listed in reference databases. The standardized assessment of insect diversity to document potential declines using DNA metabarcoding in biodiversity monitoring is widely discussed. Several projects (e.g. DINA, INPEDIV) at the Centre for Biodiversity Monitoring (ZFMK) assess insect diversity through DNA metabarcoding (> 2000 samples) and relate patterns to potential drivers of decline (e.g. pesticides, fertilizers, landscape context). To make metabarcoding applicable for upscaled biodiversity assessments, some challenges remain, which are tackled by testing and improving the laboratory and bioinformatic workflows. While comprehensive, high-resolution taxon lists can be achieved through DNA metabarcoding, there are still systematic biases within the workflow (e.g. taxonomic differences in primer efficiency, underrepresentation of small and rare taxa) while other issues arise when processing large numbers of samples for biodiversity monitoring (e.g. standardization of high-throughput protocols, lab and storage capacities). We have optimized critical steps in the molecular analysis within our projects (e.g. increased detection of low-biomass taxa) and continue to enhance the reliability of taxon identification from insect bulk samples and to improve the standardization of DNA metabarcoding methods for large-scale biodiversity monitoring.

03-O-06 - Metabarcoding plant and pollen fragments from insect malaise trap preservative ethanol: potential for large-scale biomonitoring

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The diversity and abundance of insect taxa in an area are highly dependent on available vegetation that provides structure and biological functions. The ability to increase rapid large-scale monitoring of the plant resources insects directly utilize in the environment could greatly enhance our ability to make better management decisions for insect and plant protection. Using Metabarcoding to analyze the plant components (i.e. pollen and plant fragments externally on insect bodies and/or digested plant material) found in Malaise trap preservative has the potential for rapid biomonitoring. In this study, we evaluate plant debris in malaise traps placed in 21 sites throughout Germany, with 5 traps at each site located on a gradient from the edge of agricultural land to internal areas of protected land for two weeks (May 2020), as part of the project DINA, Diversity of Insects in Nature Protected Areas. Metabarcoding of the ITS2 barcode and Illumina Miseq sequencing were used for plant identification. As these are environmental samples, there is no prior knowledge of the actual plant traces in the ethanol. Therefore, we examine rarefaction curves to determine if sufficient sequencing depth has been employed to uncover true species richness across all samples. For further evaluation criteria, we hypothesize that the diversity of plants is positively correlated to the diversity of insects recovered and the diversity of plant species will be highest within the protected area samples. Our results support plant metabarcoding from these samples as a powerful potential tool to identify which plant traces co-occur in Malaise traps with the insects. Nevertheless, improvements to reference databases, further optimization of DNA extraction and PCR steps, and quality controls may still be necessary to achieve results for rare taxa or difficult samples.

03-O-07 - DNA metabarcoding in insect biodiversity monitoring - an application of eDNA for non-lethal detection of wild bees

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Biodiversity is declining at an alarming rate worldwide. Therefore, large-scale biodiversity monitoring is urgently needed to understand changes and their drivers. Especially for insect monitoring programmes, the classical taxonomic identification of species represents a huge challenge, as it is time- and labor-intensive and requires taxonomic expertise, one of the main limiting factors. By combining this approach with DNA-based methods, especially DNA metabarcoding, monitoring activities could achieve a larger spatial coverage and sampling density could increase. We here present a DNA-based methodological approach for wild bee monitoring to identify cavity nesting wild bees, wasps and parasitoids. To develop this approach, we sampled empty nest tubes of wild bee and wasps, that had been stored at sub-optimal conditions for more than two years. We used high-throughput amplicon sequencing of the COI gene for species identification. We successfully detected Hymenoptera from as little as one brood cell. We detected species mixtures in the case of parasitized nests or nests of solitary wasps. In the latter case, we detected Arachnida, Lepidoptera and Coleoptera, which are probably remains of larval provisions. Despite the limited eDNA quality due to the storage conditions, we were able to identify > 75 % of the morphologically identified species and five additional Hymenoptera species. This approach holds great potential for a large-scale and non-lethal wild bee monitoring programme, where DNA traces are used for species detections. The eDNA approach further provides additional information on parasitation rates and food webs. By incorporating plant genetic markers, we will moreover be able to identify the composition of pollen provisions of wild bees and thereby gain inside about spatio-temporal use of resources provided by the surrounding landscape.

03-O-08 - Genetic monitoring of a decreasing arable weed – strong shifts in genetic composition in *Sherardia arvensis*

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Arable weeds, which are often considered as archaeophytes, have strongly declined in recent decades due to land-use changes and many species are now on the German Red List. Generally, arable weeds depend on regular disturbance such as is common in arable fields. But, in many of today's intensively managed agriculturally used fields the persistence of arable weeds is reduced due to increased land use intensity and management, e.g. increased sowing densities, higher crop seed purity and widespread fertilizer and herbicide application.
Among these declining arable weeds is the annual herb *Sherardia arvensis* (blue field madder). We used samples collected in 2007 and 2020 within arable fields around the city of Regensburg, Bavaria. From the original twelve populations studied in 2007, only eight could be relocated and resampled in 2020, resulting in 159 samples overall. Using multiplexed ISSR genotyping by sequencing (MIG-seq) we analysed the genetic diversity and differentiation within and among these populations and among sampling years to study the development of genetic variation within arable fields over time.
We obtained > 38 million reads and found 240 SNP loci. Analysis of genetic diversity showed similar values for each population independent of sampling year. However, genetic differentiation among samples from different years was high (> 60 %) and genetic clustering methods showed that the populations were grouped according to year and not sampling location, indicating strong shifts in genetic composition of the studied populations. These results show the impact of 13 years of agricultural use, the genotypes present in 2007 have been replaced by very different genotypes in this time period. Also, only two thirds of the populations of 2007 still existed in 2020 and future losses are likely. Future intensification and environmental challenges will likely continue to change the genetic variation of this species and thus also its perseverance in Germanys arable fields.

03-P-01 - Biodiversity monitoring of small standing water bodies in the agricultural landscape

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Small standing freshwater bodies contribute a relatively high degree of biodiversity to agricultural landscapes. In fact, they do not only support aquatic species but also a lot of merolimnic species (especially insects) who spend their larval stage in the water but migrate to the terrestrial environment as imagines. However, small standing water bodies so far are not regularly considered in the manifold ecosystem and biodiversity monitoring programmes established in Germany. This is of special concern for small standing water bodies in agricultural landscapes since these habitats are exposed to a number of potential impacts resulting from agricultural land use (e.g., nutrient overload, input of plant protectant agents, erosion).

In the framework of the project MonViA (National Monitoring of Biodiversity in Agricultural Landscapes) we develop a German-wide concept for a coherent biodiversity monitoring of small standing water bodies focusing on macroinvertebrates as well-established indicators for water and habitat quality. Next to sampling design and measurement approaches, we present indicator schemes accounting for the long-term development of macroinvertebrate diversity and related impacts on water and habitat quality.

03-P-02 - Long-term change of inner-alpine dry grassland species composition differs between protected and non-protected sites

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The Val Venosta in South Tyrol (IT) is one of the few remaining inner-alpine valleys in Central Europe that today still features highly diverse and ecologically valuable semi-natural dry grassland habitats. Long-term changes in the composition of these grasslands have rarely been assessed due to data scarcity. This might, however, allow conclusions on ecological effectiveness of conservation measures like habitat protection.
Our primary strategy is based on the reassessment of historical sampling sites documented by Josias Braun-Blanquet. For localization of the historic sites, we filtered all historically available terrain information with a digital elevation model and confirmed the potential sites by in-situ inspection. We re-identified 51 dry grassland sites and excluded 27 sites due to successional processes to forest or non-traceable historic site descriptions. We extended classical pairwise ordination methods by novel model-based approaches to assess species-level contribution to compositional differences on protected vs. non-protected sites over time based on species frequencies. Our analysis shows two main tendencies: Today's protected dry grassland sites that still feature a managed grazing system, maintained a more closely related species composition to the historical dry grassland habitat with a high frequency of typical character species. Non-protected sites are characterized by successional processes mostly due to changes in land use. This does not necessarily lead to poorer species diversity but allows different species to assemble within the sites deriving from neighboring habitats. The results emphasize that protection measures are an important tool to maintain dry grassland habitats.

03-P-05 - Peatland protection – A project that concerns us all

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Sound, (semi-)natural peatlands are characterised by their tremendous structural diversity and constitute valuable habitats for many specialised, rare and endangered plant and animal species. Besides high floristic and faunistic diversity, wet peatlands provide important ecosystem services. Especially, high carbon storage capacity, flood control, and a potentially cooler microclimate are of paramount importance for humanity. However, semi-natural peatlands drastically declined during the last decades along with land use intensification, abandonment, and habitat fragmentation.

Therefore, the project "Peatland protection" of the *Bavarian Centre for Species Conservation* of the *Bavarian Environment Agency* aims at the development of Bavarian peatland conservation concepts within the framework of the climate protection programme 2050. The project intends to provide professional competence and support in terms of peatland conservation with focus on fen conservation. It deals with three main topics against the background of biodiversity and peatland conservation: In topic I, we accompany the development of a peat preserving water management along with farmers and water authorities with focus on biodiversity. In topic II, we support concrete concepts of peat and biodiversity preserving land use practices and the development of regional value chains. In topic III, we started to establish a central peatland communication platform throughout Germany to encourage the exchange between scientists, practitioners, and farmers.

Based on the three topics, we inform the general public about matters of peatland protection, promote alternative agricultural use of peatlands, and encourage the knowledge transfer between scientists, practitioners, and farmers.

03-P-06 - Different responses of beetle biomass, diversity and functional groups to structural and compositional forest elements along a retention forestry gradient

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Various metrics such as abundance, biomass and species richness have been used to make conclusions about insect decline, making it difficult to prioritize land management actions for the benefit of insect biodiversity. Here, we analyze the biomass and diversity of functional groups of beetles collected using flight interception traps on 135 managed forest sites differing in structural variables including deadwood availability and degree of structural retention in southwestern Germany (Black Forest). Total beetle biomass increased with mean tree diameter at breast height. Diversity of all taxa increased with increasing numbers of forest layers. Different beetle functional groups responded differently to forest compositional and structural elements, especially stand structural complexity (SSCI) and effective number of layers (ENL). Our results show to promote beetle diversity and biomass forests should be managed towards multiple and heterogenous vegetation strata, similar to observations from uneven-aged stands. Additionally, conservation approaches must account for the life history of target groups to promote them.

03-P-07 - Concept for a nationwide bumblebee monitoring in agricultural landscapes – collecting data on the status and trend of a key pollinator group and identifying landscape level effects

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Bumblebees are important pollinators for a majority of wild and cultivated plant species. But what is the situation of the 41 bumblebee species native to Germany? To this day, there is no standardized and representative data basis which allows for a comprehensive understanding of the status and development of bumblebees in a landscape context. In Germany, agricultural landscapes are of special interest as around 50 % of the total land area is characterized by agricultural use. Hence, these landscapes play a crucial role in conserving and promoting bumblebees.

As part of the joint project *Monitoring of Biodiversity in Agricultural Landscapes* (MonViA), we aim to close this knowledge gap by developing a monitoring scheme of bumblebees in agricultural landscapes. Here, we describe the concept of the monitoring scheme, which is designed as a citizen science program based on monthly repeated transect walks between April and October. The bumblebee monitoring will be carried out on selected LUCAS plots that are representative for agricultural landscapes in Germany. In order to secure a long-term engagement of volunteers in the bumblebee monitoring, volunteers will be trained over the years to become bumblebee experts. We present first data of the recently started trial period and demonstrate how species and abundance data of bumblebees will be merged in the future with data on land-use and landscape to assess the impact of agricultural landscapes on bumblebee diversity and abundance.

03-P-08 - MonViA for beneficial insects: trend monitoring of important beneficial insects in meadow orchards

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Diversity and abundance of predatory insects or parasitoids are important indicators for the ecosystem service "pest regulation" and the occurrence of certain host species. As part of the project MonViA (National Monitoring of Biodiversity in Agricultural Landscapes), the long-term monitoring of beneficial insects will provide a data basis for comparing their spatio-temporal population changes depending on land use as well as exogenous factors (e.g. climate change). MonViA is a joint project between the Thünen Institute (TI), Julius Kühn Institute (JKI) and the Information and Coordination Centre for Biological Diversity (IBV) of the Federal Office for Agriculture and Food (BLE), funded by the Federal Ministry of Food and Agriculture (BMEL). In the first phase of the project, the methodology for a long-term trend monitoring is tested and further developed using suitable (minimally invasive) monitoring methods. The focus is on aphidophagous hoverflies as highly mobile organisms that move between habitats and whose populations are influenced regionally rather than locally. In contrast, less mobile, predatory bug families are considered, which are mainly influenced by local factors. The monitoring is implemented in meadow orchards as important refuge habitats in the agricultural landscape and their surroundings. The aim of this trend monitoring is the long-term modeling of the sampled land use systems and their future change on populations of these target taxa as a function of their action area. The system "trend monitoring of predatory beneficial insects" is first tested in the climatically favored and structurally rich southwestern Germany and planned to be extended to other regions in the future.

SESSION 4

Carbon Allocation and Storage in Plants and Ecosystems: New Insights from Experiments and Field Observations

CHAIRS: ***Henrik Hartmann, Günter Hoch, Michael Bahn***

Climate change potentially alters carbon (C) relations of plants and ecosystems. On the one hand, the ongoing increase of atmospheric CO2 changes plant and ecosystem stoichiometry with consequences for their functioning. On the other hand, increasing temperatures and drought might decrease net-C-uptake on the plant and ecosystem level, which, in extremis, can lead to declines in plant/ecosystem functioning and increasing mortality. Against this background, C allocation and reserve formation in plants and ecosystems have gained increasing attention over the last decade in plant ecology. However, although transport and allocation of photoassimilates to C sinks (e.g. respiration, structural growth, defense compounds, symbiotic interactions), the formation of C reserves and the re-allocation of stored C are essential processes in plants, our current understanding of the controlling mechanisms and the ecological significance of these processes, at the whole-plant level and beyond, is still surprisingly patchy. Moreover, the effect of environmental change, like drought or increasing temperatures, on the whole-plant C-balance and on C-allocation patterns, as well as the significance of C-reserves for stress resistance and resilience of plants are currently not well understood and a matter of ongoing debates. As a consequence of this lack of knowledge, we can neither properly predict the carbon balance of terrestrial ecosystems nor do we understand the factors that may drive plant mortality or survival under increasing environmental change. Within this session, we aim to bring together researchers working on different aspects of C allocation and storage in an ecophysiological context. In particular, we encourage contributions on quantitative analyses of phloem C-transport in plants, C-allocation at the whole-plant and ecosystem level and studies on the ecological significance of C-reserves for stress tolerance.

04-O-01 - Carbon transport and allocation of mature Norway spruce during post-drought recovery after five years of repeated summer droughts

Kyohsuke Hikino[1], Jasmin Danzberger[2], Vincent P. Riedel[1,3], Benjamin D. Hesse[1], Timo Gebhardt[1], Karl-Heinz Häberle[1,4], Benjamin D. Hafner[5], Romy Rehschuh[6], Nadine K. Ruehr[6], Melanie Brunn[7], Simon M. Landhäusser[8], Marco M. Lehmann[9], Franz Buegger[2], Fabian Weikl[1,2], Karin Pritsch[2], Thorsten E. E. Grams[1]

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Aside from drought responses, recovery of tree functionalities is an important aspect for survival under increasing drought frequency predicted for the future. However, knowledge on how productive and mature forest trees cope with repeated drought events is still missing. This contribution presents results from a ^{13}C-labeling experiment on approx. 70-year-old Norway spruce trees during their recovery from five years of recurrent summer droughts. Spruce trees had been exposed to droughts from spring to late fall between 2014 and 2018 through a complete exclusion of precipitation throughfall. During that time these trees showed significant drought effects such as reduced total needle surface area, stem growth, and fine root biomass. In early summer 2019, the drought stressed trees were watered to investigate recovery responses and processes. In parallel with the watering, we performed a whole-tree ^{13}C labeling treatment in the canopy and traced the ^{13}C label to various above- and belowground carbon (C) sinks to elucidate the resilience of whole-tree C transport and allocation during the post-drought recovery. The speed of C transport from canopy to soil CO_2 efflux in previously drought-stressed trees fully recovered to the control level within two weeks after drought release, and hence showed high resilience to the recurrent summer droughts. Furthermore, the previously drought-stressed trees significantly increased the investment of both current and stored C into belowground sinks, especially into fine root and coarse root biomass. The observed recovery of C transport and the shift in C allocation towards belowground organs both supported the regeneration of the water-absorbing fine root system. Overall, Norway spruce showed a fast physiological response and recovery after five years of prolonged drought, which is an important prerequisite for the ability of spruce to regain productivity, by rebuilding fine root biomass and needle surface area.

04-O-02 - Effects of drought on nitrogen uptake and carbon dynamics in trees

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Research on drought impact on tree functioning is focused primarily on water and carbon (C) dynamics. Changes in nutrient uptake might also affect tree performance under drought and there is a need to explore underlying mechanisms.
We investigated effects of drought on a) *in-situ* nitrogen (N)-uptake accounting for both, N availability to fine-roots in soil and actual N-uptake, b) physiological N-uptake capacity of roots, and c) the availability of new assimilates to fine roots influencing the N-uptake capacity using ^{15}N and ^{13}C labelling. We assessed saplings of six different tree species (*Acer peudoplatanus, Fagus sylvatica, Quercus petraea, Abies alba, Picea abies, Pinus sylvestris*).
Drought resulted in significant reduction of *in-situ* soil N-uptake in deciduous trees accompanied by reduced carbon allocation to roots and by a reduction in root biomass available for N-uptake. While physiological root N-uptake capacity was not affected by drought in deciduous saplings, reduced maximum ammonium but not nitrate uptake was observed for *A. alba* and *P. abies*.
Our results indicate that drought has species-specific effects on N-uptake. Even water limitations of only 5 weeks as assessed here can decrease whole plant inorganic N-uptake independent of whether the physiological N-uptake capacity is affected or not.

04-O-03 - Key genes involved in carbohydrate regulation in trees under drought stress

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Unlike annual and herbaceous plant species, the survival strategy of trees must consider their long-life span, high biomass production and changing environmental conditions over decades. Managing carbon allocation into storage efficiently and flexibly is a central part of this ability. The genetic regulation activated by trees in response to drought stress is far from being fully understood, certainly at the whole-tree level. In this study, young poplar trees (*Populus alba*; a genome-deciphered species) were subjected to soil drought stress, following a combined analysis of nonstructural carbohydrates (NSC) and gene expression profile (RNAseq), across leaves, stem and roots. Soil drought caused a cascade of gene expression responses, from carbohydrate metabolism enzymes to the stress transcription factor SnRK1. Unexpectedly, roots showed lower responses than stem and leaves. Starch degradation in roots was accompanied by sucrose synthesis gene upregulation, without concomitant sucrose accumulation. Instead, sucrose accumulated in stem and leaves, accompanied by upregulation of tonoplast transporters and vacuole invertases. A specific sugar transporter expression correlated to a decrease in sucrose concentration across tissues and treatments, suggesting sucrose export from cells to the apoplast. A specific Trehalose phosphate synthase (TPS) gene was negatively correlated to sucrose levels across tissues and treatments, indicating its general role in regulating sucrose levels in cells. During drought, three other TPS genes and a specific Trehalose phosphate phosphatase gene were upregulated across tissues, indicating a specific drought-induced regulation of sucrose. A specific drought-induced AGPase was identified, hinting that starch was synthesized and not only degraded under drought. This study offers a new perspective on NSC dynamics at the whole-tree level, considering key molecular regulators together with biochemical quantification.

04-O-04 - Leaf phenology and non-structural carbohydrate dynamics along the vertical gradient of mature tree canopies

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Leaves in a tree crown experience different light environments along a vertical gradient, leading to different amounts of carbon being sequestered. With leaf phenology also potentially differing along that microclimatic gradient, it could be expected that the seasonal dynamics and size of the non-structural carbohydrate (NSC) pool of twigs would differ considerably depending on the position within the crown.

To assess the effect of light availability and leaf phenology on the NSC dynamics along the depth of the canopy, we measured the NSC content in twigs from the top and bottom of the crowns of nine tree species in a mature, temperate forest near Basel, Switzerland, throughout the year 2020. We also recorded the leaf phenology along the vertical gradient of the crowns and took continuous light measurements at various locations in the canopy.

There was hardly any difference in bud-break timing within the crowns, with the broadleaved trees showing bud-break on average only 1 day earlier at the bottom of the crown than at the top. In the conifers that difference ranged from 2 to 7 days. Light availability in the lower crown was around 30 % of that at the top during the growing season. In most species, the NSC concentrations were strikingly similar in top and bottom twigs throughout the season, maintaining the same NSC levels despite the stark differences in light availability. Notable exceptions are the two ring-porous species *Quercus petraea* and *Fraxinus excelsior*, both reaching the minimum xylem starch levels about one week later at the bottom than the top, with a subsequent delay in refilling after leaf-out at the lower crown.

The very similar NSC concentrations throughout and especially at the end of the season support the idea of NSC storage being an actively regulated, rather than a passively driven pool.

04-O-05 - Shift in respiratory substrate use towards lipid metabolism induced by stem girdling?

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When carbon (C) assimilation becomes smaller than respiration, trees may use stored resources to compensate for a negative C balance. In species that store C not only in the form of carbohydrates but also lipids, storage mobilization thus can induce a substrate shift, but there are few studies addressing this in the field. On July 4th 2018 we girdled 6 mature poplar trees and compared them to 6 un-girdled control trees in the Thuringian forest (Germany) to study storage mobilization and potential substrate shifts. We installed a novel stem chamber system for quasi-continuous measurements of CO_2 and O_2, sampled stem-emitted CO_2 via flasks for $\delta^{13}CO_2$ and $\Delta^{14}CO_2$ measurements and took stem cores for analyzing non-structural carbohydrates. We calculated the ratio of CO_2 efflux to O_2 influx (apparent respiratory quotient or ARQ) that allows inferences on respiratory substrate sources. Shifts in $\delta^{13}CO_2$ can indicate substrate shifts between carbohydrates (higher $\delta^{13}C$) and lipids (lower $\delta^{13}C$). We used the bomb-radiocarbon method to determine the mobilization of older C reserves. For pre-girdling we observed no differences between both treatments. After the girdling event, CO_2 fluxes declined in girdled trees, while differences in O_2 fluxes were less pronounced. In 2019, CO_2 and O_2 fluxes were significantly lower in girdled trees. Girdling resulted in an almost immediate reduction of ARQs. Two weeks after the girdling event, $\delta^{13}CO_2$ of girdled trees was more depleted. Mean $\delta^{13}CO_2$ was significantly lower in girdled trees by ~ 3 ‰. The combination of lower $\delta^{13}CO_2$ and the lower ARQ in girdled trees provides a strong support for a substrate shift from carbohydrates to lipids. We found no treatment effect in starch and soluble sugar concentrations of stem cores. The mean $\Delta^{14}C$ of emitted CO_2 differed significantly between 8 ‰ (un-girdled) and 16 ‰ (girdled). This may support the idea that mature poplar trees started mobilizing slightly older C reserves.

04-O-06 - VOC emission in spruce as cause for bark beetle host selection

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The European spruce bark beetle, *Ips typographus* is one of the most ecologically relevant biotic agents for European forests. Especially under stressful conditions beetles can affect whole landscapes of trees and favour mortality. While many aspects of the beetle's life cycle have been investigated, the host choice of pioneer beetles is still not understood. It is suggested that the emission of volatile or olfactoric compounds may be responsible for the determination of a suitable host even though there are no empirical studies that can support this statement yet. Methods for measuring volatiles differ greatly depending on the plant and organ of interest and are especially challenging when investigating trees and their stems. Here we describe our standardized method for VOCs in particular monoterpene measurements on tree stems in the field. This method consists of a chamber system coupled with a mobile GC/MS and/ or absorption tubes which enables a quantitative and qualitative analysis of *in situ* volatile emissions. We will report first results on the composition and concentration ranges of volatile compounds emitted by spruce trees which could serve as clues for beetles to locate weakened and stressed trees.

04-O-07 - Monitoring spatial and temporal growth and carbon dynamics in roots by co-registration of Magnetic Resonance Imaging and Positron Emission Tomography

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Individual plants vary in their ability to respond to environmental changes. The plastic response of a plant enhances its ability to avoid environmental constraints, and hence supports growth and reproduction, and evolutionary and agricultural success.
Due to the opaque nature of soil, a direct observation of belowground processes is not possible. Major progress in the analysis of belowground processes on individual plants has been made by the application of non-invasive imaging methods including Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET).
MRI allows for repetitive measurements of roots growing in soil and facilitates quantification of root system architecture traits in 3D. PET, on the other hand, opens a door to analyze dynamic physiological processes in plants such as long-distance carbon transport in a repeatable manner. Combining MRI with PET enables monitoring of carbon tracer allocation along the transport paths (i.e. roots visualized by MRI) into active sink structures such as nodules.
We will highlight our approaches for gathering quantitative data from both image-based technologies. In particular the combination of MRI and PET has high potential for gaining deeper insights into dynamics of root growth and, for example, interactions with microbes for revealing novel traits demanded in ecological studies or breeding programs for future crops.

04-O-08 - A trade-off in the carbon allocation of non-vascular plants: nitrogen fixation in relation to photosynthetic performance

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Rising atmospheric CO_2 levels potentially fertilize photoautotrophic organisms and may result in increasing primary production. Whether net photosynthetic assimilation of CO_2 is promoted under global climate change might depend on the availability of nitrogen (N) in nitrogen-limited ecosystems. The Non-vascular organisms, bryophytes and lichens, are associated with diazotrophic cyanobacteria and are assumed to play a major role in global nitrogen cycles. To adjust their photosynthetic performance to elevated CO_2 concentrations, cyano-associated lichens and bryophytes might increase nitrogen-fixation to maintain C/N stochiometry. As nitrogen is a major component of proteins such as the key photosynthetic enzyme RuBisCO, nitrogen content is directly linked to photosynthetic performance. Relations between organism nitrogen content, nitrogen deposition, growth, respiration, and photosynthetic capacity are measured in a field experiment. The relations will be implemented in the process-based numerical model 'LiBry' to extend the model to include a trade-off in the allocation of assimilated CO_2 to nitrogen fixation. The combination of physiological data on photosynthetic properties of different ecotypes of non-vascular vegetation together with monitoring of climate and biomass growth allows for a unique dataset to describe and validate the dependences of nutrients in the model. The model-based approach allows for the extrapolation of primary production and nutrient cycling on a global scale under consideration of changing climatic conditions.

SESSION 5

Nature and People –

Pathways between Biodiversity and Human Health

CHAIRS: ***Rachel Rui Ying Oh, Aletta Bonn, Melissa R. Marselle***

Society is exposed to significant challenges relating to human health and wellbeing. As global populations choose and continue to reside in cities, they are subjected to intense urbanisation and loss of physical contact with nature. A recent rise in chronic and non-communicable diseases such as obesity and poor mental health has also been documented in urban residents. Conversely, climate change presents a huge threat to our biodiversity, optimal ecosystem functioning and its delivery of ecosystem benefits. With the increased frequency and prolonged duration of extreme climate events, our natural ecosystems may no longer be able to function optimally and sustainably. Given the importance of biodiversity's contribution to human health and wellbeing, one questions whether and how experiencing nature under these urbanisation and climatic challenges provides relevant health and wellbeing benefits. As such, this session hopes to understand the contribution of biodiversity to human health and wellbeing, under the dual pressures of extreme urbanisation and climate change. It hopes to also gain insights into the casual pathways through which health and wellbeing benefits are delivered, and to apply the knowledge towards managing potential synergies between different academic disciplines to improve public health and the conservation of biodiversity.

05-O-01 - Health and wellbeing benefits from nature experiences in Singapore may depend on strength of connection to nature

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A growing number of policies and programs in cities aim to increase the time people spend in nature for the health benefits delivered by such interactions. Yet there has been little research investigating whether nature experiences can continue to deliver health and wellbeing benefits even under conditions of extreme urbanisation and high population density. Here, we assessed the relationships between nature dose (frequency, duration and intensity) and three mental (depression, stress and anxiety) and two physical (high blood pressure, diabetes) health outcomes in Singapore, one of the most intensely urbanised cities in the world. Our analyses controlled for individual factors including socio-economic status, nature connection (nature relatedness), and whether people with poor health are prevented by their condition from visiting greenspaces. Our results suggest that the association between nature dose (specifically duration) and wellbeing is moderated by nature connection. Specifically, people with stronger nature connection were less likely to be depressed, stressed and anxious regardless of duration of nature dose, while for those with a weaker connection to nature, spending longer in nature was associated with being more depressed, stressed and anxious. We did not find a relationship between nature dose and high blood pressure or diabetes. In this context of a highly urbanised and densely populated city, our results highlight a complex relationship between nature dose and mental health.

05-O-02 - Urban green space soundscapes and their perceived restorativeness

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1. The positive influence of urban green spaces on human health and well-being is well known, while the pathways are little understood. Past research has largely focused on visual stimuli, yet the auditory pathway is also an important means for contact with nature.
2. The sonic environments of urban green spaces, however, are rarely entirely natural and many differ in their composition of natural sounds and anthropogenic noise. Few studies have investigated how these differences may impact the restorative potential of these soundscapes and, in particular, how the presence of traffic noise may constrain the benefits of natural sounds.
3. To address this gap we examined differences in the perceived restorativeness and perceived restorative outcomes across a gradient of eight park soundscapes that differed in bird and traffic sounds. In a laboratory setting, 162 participants listened to sound samples and reported on perceptions of the soundscapes and restorative potential and outcomes.
4. The results strongly indicate that park soundscapes with a rich array of perceived bird sounds and minimal perceived traffic noise offer the greatest perceived restoration. Traffic noise was found to moderate the positive effect of bird sounds. The duration of time lived in the city and noise sensitivity were also positively associated with greater perceived restorative benefits, whilst noise sensitive people were also more negatively affected by traffic noise.
5. The promotion of highly natural soundscapes in urban green spaces and the reduction of traffic noise can provide nature-based solutions to human health and well-being in urban areas.

05-O-03 - Why cultural ecosystem services matter most: Exploring the pathways linking greenspaces and mental health in a low-income country

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Exposure to urban greenspaces promotes a variety of mental health benefits. However, much of the evidence for these benefits is biased towards high-income countries. In contrast, urban areas in low-income settings that have the highest rates of urbanisation remain understudied. Given the increasing burden of mental ill-health associated with urbanisation in low- and middle-income countries (LMICs), there is a clear need to better understand the role urban greenspaces play in mitigating mental ill-health. We used a novel combination of research methods (participatory video, focus groups and the Q-methodology) in a rapidly urbanising low-income city (Kathmandu, Nepal) to explore residents' perspectives on ecosystem services, and the pathways linking greenspaces to mental health. Residents indicated that greenspaces are linked to mental health through pathways such as reducing harm (exposure to air pollution and heat), restoring capacities (attention restoration and stress reduction), building capacities (encouraging physical activity, fostering social cohesion and child development) and causing harm (human – wildlife conflicts, gender discrimination). It is likely that a combination of such pathways triggers mental health impacts. Of all ecosystem services, cultural services such as providing settings for recreation, or intellectual or mental interactions with greenspaces involving analytical, symbolic, spiritual or religious activities were most preferred. Our findings emphasise that cultural ecosystem services provide are a fundamental basic need which all people, including low-income residents, depend on to participate meaningfully in society. Urban greenspaces therefore play a pivotal role in reducing the burden of mental ill-health for low-income residents in LMICs. Greater efforts to increase the quantity, quality and accessibility of urban greenspaces may help to address current health inequalities in LMICs.

05-O-04 - Linking biodiversity and health - a conceptual framework

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Biodiversity provides the foundation for human health and wellbeing. This is increasingly recognized by global and regional policy developments, e.g. the collaboration of the Convention on Biological Diversity (CBD) and the World Health Organization (WHO). While positive and negative associations of nature and health have been established in general, we still lack a mechanistic understanding of direct pathways between biodiversity, health and wellbeing. These pathways may also be impaired by the increased disconnection between people and nature, and a lack of nature experience. Here, we present a conceptual framework for understanding the specific causal pathways through which biodiversity directly affects human health and provide selected case study examples.

05-O-05 - Butterfly Monitoring Germany - the benefits of counting butterflies

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The Citizen Science-project "Butterfly Monitoring Germany - TMD" is running for 16 years, now. The basis of the TMD are volunteer transect walkers who count butterflies along a defined route. The scheme's success depends on the number of the participating volunteers and the effort they take by spending their free time collecting butterfly data all over Germany. While the benefits of such projects for science and public and private stakeholders are well understood, relatively little is known about the benefits participants get from these projects as well as their personal backgrounds and motivations. Furthermore, very little is known about their expectations. In this talk, we present the results of a questionnaire sent out to all participants of the TMD in 2019.

The main results are that most transect walkers do not have a professional background in this field, but have a high educational level and are close to retirement. An important motivation to join the project is to preserve the natural environment and to contribute to scientific knowledge. A personal benefit for participants is that they enhance their own knowledge about butterflies and especially their ability to identify different species (taxonomic knowledge). Participants do not have specific expectations regarding the project, beyond its proper management and coordination, but have an intrinsic sense of working for a greater good. The willingness to join a project is higher if the project contributes to the solution of a problem discussed in the media (here: insect decline) or during difficult times such as the COVID-19 pandemic, giving participants the feeling of doing something useful.

05-O-06 - Features in and around residential gardens affecting the presence and abundance of questing *Ixodes ricinus* ticks

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The wood tick *Ixodes ricinus* serves as vector for Lyme disease borreliae. People may be exposed to these ticks in urban settings, such as residential gardens. Little is known about garden characteristics that may support a tick population. To determine whether particular features in and around gardens support or limit the occurrence and abundance of questing *I. ricinus* ticks, we sampled them in gardens in the Braunschweig region that differed in various intrinsic and extrinsic parameters. We recorded the number of questing ticks on transects and, by using mixed-effects generalized regression models, we related their occurrence and abundance to various garden characteristics, to meteorological parameters, and to landscape features in the vicinity. We detected questing *I. ricinus* ticks in about 90 % of the 103 surveyed gardens. Our occurrence model predicted with an R^2 of 0.31 the highest probability of questing ticks on transects with hedges or groundcover in gardens that are located in a neighborhood with large proportions of forest. The abundance of questing ticks in a garden was similarly influenced. The overlap of habitat suitability for beneficial and harmful organisms constitutes a considerable tradeoff between the benefits of urban ecosystem services and the potential or perceived health risks associated by the presence of questing ticks. Thus, it is important to raise awareness that particular areas in a garden may be more likely to harbor ticks than others and that garden owners are well advised to check themselves routinely for ticks. Garden owners who strive to reduce the number of ticks on their premises may purposefully limit the amount of litter and ground cover in highly frequented areas. We conclude that questing *I. ricinus* ticks are frequent in residential gardens in Northern Germany and likely associated with intrinsic garden characteristics on a small scale and with extrinsic factors on a local scale.

05-O-07 - An ecosystem service perspective on mountain lakes across socio-ecological contexts

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Mountain lakes are affected by climate change and anthropogenic use requiring measures to support conservation and ecosystem service (ES) provision. However, ES of mountain lakes and their relation to the regional socio-ecological context remains largely unexplored, which constitutes a critical knowledge gap to support sustainable management strategies. Hence, we aimed at identifying and assessing key ES of 15 study lakes located in two regions in the European Alps. Key ES were identified in workshops involving local stakeholders and experts. These ES were quantified using 29 multi-metric indicators based on limnological, spatial and socio-economic data and evaluated in regards of 12 socio-ecological context variables covering aspects related to environmental setting, land cover, accessibility, and beneficiaries. Stakeholders perceived eight key ES: maintaining populations and habitats, surface water, recreation, aesthetic, representation, research, education as well as existence, option, or bequest value. We identified four groups of lakes featuring differences in socio-ecological context variables. Most ES (surface water, recreation, representation, research, and education) differed significantly across these groups. In contrast, maintaining populations and habitats, aesthetic as well as existence, option or bequest value were rather weakly related to the socio-ecological context. Across study regions, stakeholders' perceptions on key ES partially overlapped (i.e. maintaining populations and habitats, aesthetic, and recreation); however, they also reflected the respective socio-ecological context matching the differences in ES found across groups of lakes. Our findings foster a deeper understanding of mountain lakes' contributions to human well-being and can support decision-making by identifying different groups of lakes potentially requiring tailored management strategies.

05-P-01- Storytelling: The role of biodiversity in public

Exploring dynamics that affect biodiversity narratives with a systems approach

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The value of biodiversity can be considered from various points of view, including ethical, ecological (i.e. functional), economical (or financial), cultural perspectives, with all their juridical, political or social consequences.
However, this is contrasted by the vast lack of awareness and knowledge of the relevance of biodiversity present in the public. Unlike topics as nuclear energy or electric mobility, biodiversity enjoys a rather unobtrusive reputation, being viewed as “nice to have” despite its relevance to human survival.
Consolidating public perceptibility of biodiversity as a common good implies the development of publicly accessible narratives which respond to a preferably wide variety of viewpoints. Whilst not only access and understandability of content are essential tools when seeking a large audience, the performance of a narrative plays an estimable role. If the intrinsic interest of the audience is limited, their capability of establishing an emotional connection to the content is narrowed as well. Consequently, an audiences’ interest ought to be fueled extrinsically.
Based on this hypothesis, it can be assumed that storytelling in communication of biodiversity plays a crucial role as it carries the task of getting the audience interested in a way which evokes involvement and curiosity. Here, we address this question with a systems approach, i.e. by applying System Dynamics to structural and contextual narrative cornerstones which aims to reveal and visualise conducive and adverse key dynamics entangled with subject complexity, so to explore the development of narratives which are appropriate to both topic and audience

SESSION 6

The Future of Forest Ecosystems, Open Forests and Other Conservation Strategies

CHAIRS: ***Franka Huth, Thomas Gottschalk***

Over the last decades forest ecosystems worldwide have been strongly disturbed and changed by various factors such as drought, fire, storm, insects and direct human impacts. Those changes accompanied by a reduced canopy closure have a huge impact on different ecosystem services. For several centuries within the former millennium, anthropogenic open forests were common in Central Europe, which were characterized by canopy openness dependent on human disturbances. Due to the loss of these forests as well as the loss of the megafauna and the implementation of a "subnatural forest praxis" a huge number of species has been disappeared from forests and currently several species are facing a rapid decline throughout Central Europe. The aim of the session is to address a broad spectrum of scientific disciplines. Of particular interest are presentations detailing scientific work focusing on: (i) innovative methods to record and analyse the state of forest ecosystems, (ii) the identification of reasons for disturbances within forest ecosystems, (iii) their effects for ecosystem functions, services and processes, and (iv) the development of conservation strategies, management concepts and to preserve the vitality and functions of forests.

06-O-01 - Forest openness in Central Europe before the onset of agriculture - What do we know from palynology?

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The degree of forest openness during the Early and Mid-Holocene, before agriculture was established in Central Europe, is long debated. On the one side, the presence of large herbivores, such as aurochs or horse, may suggest that forests of that time were naturally open. Following e.g. the Vera-hypothesis, the large herbivores maintained a 'half-open park-like landscape'. On the other side, the interpretation of pollen data does not provide evidence of such a half open landscape and instead indicates that the forests were densely closed. The interpretation of pollen data is far from simple, however, particularly when it comes to past openness. In Central Europe, many open taxa produce much less pollen then most tree taxa and are therefore under-represented in the pollen records. Over the past decade, several methods to correct for this bias in pollen data have been developed, e.g. REVEALS for pollen data from large lakes, LOVE and Marco Polo for pollen data from small forest hollows or EDA for detecting past vegetation pastern related to soil types or the relief. The presentation will shortly introduce the key methods, discuss present results and propose future research approaches for a more accurate understanding of past vegetation.

06-O-02 - Managing forests for butterfly conservation: a case study on the Southern White Admiral

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Many butterfly species of open forests have been rapidly declining during the last decades. The Southern White Admiral (*Limenitis reducta*), which is an umbrella species for the preservation of insect communities in open forests, has become one of the rarest and most threatened butterfly species in Germany. Despite the strong decline of northern alpine *L. reducta* populations, detailed information on their ecology is currently missing. We studied the Southern White Admiral in its last strongholds in the Swabian Jura and implemented exemplary management measures, i.e. the maintenance of open ride edges and small-scale clear-cutting. We estimated survival rates in different life stages, population sizes, and the dispersal capacity of adult *L. reducta*. Survival was less than 3 % from the egg to the imago and population sizes were generally small. Imagos did rarely cover distances > 1 km. Nevertheless, many newly created habitat patches were colonised within the first year after the implementation of the management measures. We demonstrate that open patches in a forest matrix are valuable habitats for threatened butterfly species and provide a long-term perspective for the preservation of open forest butterflies in the Swabian Jura.

06-O-03 - Nutrient export through grazing by wild red deer aids the conservation of open habitat types

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The deterioration of (semi-)natural habitats is an ongoing phenomenon. In particular, heaths and grasslands, which have been created by extensive agricultural land use, decline in quality and area all over Europe. These open habitat types associated with nutrient-poor soil conditions are highly vulnerable to eutrophication, which not only results from local agricultural intensification but also from atmospheric deposition. For long-term habitat conservation, local conservation measures hence need to warrant habitat-specific nutrient conditions in spite of continuous atmospheric input.
Grazing by free-ranging herbivores, e.g. red deer (*Cervus elaphus*), has recently come into focus as an alternative option for open habitat conservation, especially for areas difficult to access for humans or livestock. To evaluate the magnitude of nutrient fluxes by wild red deer, we marked eight plots of 225 m^2 in two habitat types (European dry heaths, lowland hay meadows), respectively, on a military training area in Germany. Per plot, we collected data on vegetation productivity, forage removal, dung quantity, plant and faecal nutrient concentrations to quantify import and export of nitrogen (N) and phosphorus (P) over one year.
Red deer dung deposition amounted to an annually imported dung dry mass (mean ± SE) of 155 ± 15 kg ha^{-1} in heathlands and 97 ± 3 kg ha^{-1} in grasslands. This translated to an N import of 3.0 and 2.5 kg $ha^{-1}a^{-1}$, but the N export through grazing amounted to 18.8 and 34.4 kg $ha^{-1}a^{-1}$, respectively. Even with an estimate for total N import of both faeces and urine, N import was much lower than the export. Also the export of P notably exceeded the import in both habitat types. Consequently, wild red deer can mitigate the effects of atmospheric nutrient deposition in protected open habitat types because of high nutrient removal by grazing and low import through excreta.

06-O-04 - Phylogenetic isolation of host-trees reduces resource tracking by herbivorous insects and their parasitoids

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Parasites use movements and sensory capabilities in foraging strategies that enable them to track host-resources. Such resource tracking may be limited by spatial isolation of hosts due to limited movements and sensory information. However, even spatially proximate hosts can be difficult to track. We hypothesise that when host-trees in a forest are phylogenetically isolated i.e. surrounded by phylogenetically distant neighbours, specialized herbivorous insects might find it difficult to track resources due to odour masking, or dispersal limitation imposed by the neighbouring trees. We studied resource tracking by groups of herbivorous insects and their parasitoids on individual oak trees that differed in the degree of phylogenetic isolation. For 4 years, we determined abundance of groups of herbivorous insects, the extent of herbivory, and potentially important leaf parameters. We also reared the sampled ectophagous Lepidoptera to determine parasitation. Phylogenetic isolation reduced the tracking of resource quantity by ectophagous Lepidoptera and their parasitoids. Tracking of resource quality by ectophagous Lepidoptera as well as the resource tracking by endophagous herbivores was not affected by phylogenetic isolation. Our results suggest that host trees should escape from their relatives to avoid tracking of their resources by herbivorous insects.

06-O-05 - Disentangling the importance of space and host for beetle, fungi and bacteria diversity: Lessons from a large dead-wood experiment

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European forests have been severely changed by forest management. Those changes include not only the stand structure and tree species composition but also the extraction of timber, reducing the amount and heterogeneity of deadwood. Especially saproxylic species, which depend directly on deadwood, are critically affected in their diversity. To guide conservation to efficient biodiversity strategies, we require a better understanding of which scales matter across saproxylic species groups. We aim to disentangle the relative importance of (i) space vs. host, (ii) within space, the levels region vs. landscape, and (iii) within host, the levels host clades vs. host tree species for saproxylic diversity. We simultaneously consider beetle, fungal sporocarp, fungal mycelium, and bacteria communities in one unified framework. We used a large nested experiment comprising deadwood of 11 tree species, replicated across plots with management gradient in three landscapes across the regional scale (Germany), and applied multiplicative diversity partitioning. Beetle and fungal sporocarp beta diversity were explained by space and host to equal amounts, whereas fungal mycelium and bacteria beta diversity was mainly explained by the host. Across taxa, within space, the landscape scale was more important than the regional scale for beta diversity. However, for common and dominant beetle, sporocarp, and bacteria communities, the regional scale also contributed strongly to explain diversity. Within host, beetle and sporocarp beta diversity was explained by both host clade and host tree species, whereas fungal mycelium and bacteria beta diversity was mainly explained by host tree species. The inconsistent pattern of beta diversity across species groups with space and host impedes unified, straightforward conservation strategies and calls for taxa-specific conservation prioritization.

06-O-06 - Diversity of saproxylic beetles in tree hollows influenced by tree hollow characteristics, forest and landscape structure

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Tree hollows with wood mould are considered key structures for a high biodiversity in forests. They offer a constant microclimate for many years and nutritional resources for many endangered saproxylic arthropod species. To analyze the effects of tree hollow characteristics as well as forest and landscape structure on the diversity of saproxylic beetles in tree hollows in managed forests, we examined 40 - 50 tree hollows in beech trees in each of three Bavarian state forestries (BaySF forestries Ebrach, Fichtelberg, and Kelheim) over two years using emergence traps. For the first time we utilized forest inventory data collected by the state forestries to analyze beetle diversity in tree hollows. We collected a total of 283 saproxylic beetle species (5880 individuals) in the three forest regions, 22 % of which were on the Red List. We found that characteristics of the tree hollows themselves like the size of the hollow entrance or the degree of decomposition of the wood mould had the strongest influence on diversity of saproxylic beetles in the hollows, as well as parameters of the near surroundings like the number of microhabitat structures within a 30 m radius. At larger spatial scales, the amount of deadwood that was calculated using forest inventory data, had a positive effect on saproxylic diversity up to a radius of 300 m around the tree hollows in the Ebrach forestry, consisting mostly of broadleaved trees. However, in the Fichtelberg forestry, dominated by coniferous trees, only the portion of beech trees up to a radius of 100 m around the tree hollows had a positive effect on the diversity of saproxylic beetles. Landscape structure at even larger spatial scales proved to have less effects on saproxylic beetle diversity in the hollows. These findings could contribute to shifting the focus of conservation efforts more towards habitat quality of single tree hollows and smaller forest patches than parameters of landscape structure at larger spatial scales.

06-O-07 - The effect of forest management on cavity nesting bees, wasps and their natural enemies in the Black Forest

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Forest management can lead to drastic changes in biotic and abiotic conditions and alter ecosystem processes and ecological communities. Ecological communities are linked in networks of mutualistic and antagonistic processes such as parasitism. These networks hold crucial information about the stability and functionality of the system and about the associated ecosystem function, parasitism.
We used 180 standardized trap nests for Hymenoptera and their associated parasitoids on 45 forest plots (1 ha) arranged in 15 management triplets in the Black Forest, Germany. We studied 'close to nature silviculture', 'process protection' and 'clear cuts' to test in which way forest management and vegetation characteristics affect the abundance and richness of cavity nesting bees, wasps and their natural enemies and whether it changes parasitism rate and the network structure of host and parasitoid networks.
We found the highest abundance of host and parasitoids on clear cut plots. Both were affected positively by the Shannon diversity index of the vegetation. However, the estimated host richness was highest on close to nature silviculture plots. Parasitoid richness was not related to management, but was related to host richness. Parasitism rate increased with parasitoid abundance and was higher on east exposed plots. Networks on CC plots were less specialized and more linked than CNS and PP networks. Communities were mainly structured by management, vegetation diversity and elevation. Our results highlight the importance of early successional habitats for cavity nesting bees, wasp and their natural enemies and its effect on the stability and speciality of their networks. With this we aim to improve the conservation of species and their associated ecosystem functions in a changing forest environment.

06-O-08 - Population demography of feral honey bee colonies in German forests

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The European populations of the honey bee (*Apis mellifera)* are considered to consist of managed colonies only. However, recent censuses showed that wild living colonies still occur in various countries and that they may nest at locations far away from apiaries. Since knowledge about feral honey bee populations is relevant for various fields including apicultural management and conservation, we monitored the population fluctuations of feral colonies in three forest areas in Germany (Swabian Alb, Coburg/Lichtenfels and Schongau/Weilheim) over up to four years. We found wild honey bee nest sites by inspecting cavities of the black woodpecker that had been previously mapped, and we documented the fate of individual colonies (n = 111) by visiting cavities three times per year. Each summer, about 10 % of all intact woodpecker cavities were occupied by feral colonies, corresponding to densities of about 0.2 colonies/km^2. While most colonies (90 %) survived until autumn, only 16 % survived the winter, so that colony densities dropped to only 0 - 0.04 colonies/km^2 until spring. Colonies that managed to survive the winter had a high chance to survive until the next summer (89 %). The resulting annual survival probability and average life span of feral honey bee colonies were 12.7 % and 0.65 years respectively. For the population to be self-sustaining, each successfully overwintered feral colony would need to produce 6 - 7 swarms per year. However, since they might produce only 1 - 2 swarms on average, we conclude that the population is heavily dependent on the yearly immigration of swarms from apiaries. Our findings demonstrate that the honey bee is a semi-domesticated insect in Germany. Forest dwelling feral colonies likely compete with other cavity-nesters and they might provide pollination service to the surrounding land, but mostly in the second half of the year. It is unclear whether feral honey bees play a role in disseminating bee parasites and pathogens.

06-O-09 - FraDiv: Strategies for biodiversity conservation - Establishment of a biodiversity-ecosystem functioning experiment against the background of the ash dieback disease

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The ash dieback disease is drastically affecting European ash (*Fraxinus excelsior* L.) in its natural distribution range (e.g. Coker et al. 2018) involving a rapid transformation of ash-rich forest ecosystems that puts many associated species at risk (Hultberg et al. 2020). Whereas numerous studies address the infection pathway of ash dieback and focus on identifying resistant genotypes, forest manager have to deal immediately with the loss of a key tree species for maintaining ecosystem functioning. The project FraDiv, located in Schleswig-Holstein, Germany, aims at quantifying impacts of ash dieback on ecosystems in near-natural forest remnants using both an observational (FraDiv^{obs}) and an experimental platform (FraDiv^{exp}).

In winter 2019/2020, FraDiv^{exp} was established in a full BEF design: based on a pool of local tree species considered as potential substitutes for the functioning of *F. excelsior*, 12 replicated forest communities were created and established directly underneath the remains of collapsing forest canopies along a hydrological gradient. The primary goals of FraDiv^{exp} are (1) quantifying the effects of tree diversity on ecosystem functioning (e.g. tree growth, associated floristic und fungal species composition) and (2) assessing its capacity to buffer effects of biotic stress induced by a fungal pathogen. First insights of FraDiv^{exp} encompass a successful establishment of the experiment with 25.200 trees planted involving each all monocultures, and all combinations of 2-, 4- and 5-species mixtures. One year after initial planting total survival of the trees was at 95 %. In this early phase of FraDiv^{exp}, survival of trees was species-specific and driven by initial individual tree size. In a joint analysis with FraDiv^{obs}, future results of FraDiv^{exp} will meet the imminent need for management guidelines, thereby contributing to both biodiversity conservation and sustainable forest management in the current phase of ash dieback.

06-O-10 - Lower species diversity of seven taxonomic groups in pure European beech stands compared with pure stands of Douglas-fir and Norway spruce or mixed stand of both conifers with beech

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Climate change impacts native forest ecosystem dynamics. Increased storm frequencies and severities as well as longer summer droughts are major threats for the provision of ecosystem goods and services from forests. The promotion of non-native tree species that may be well adapted to expected future climates is seen as a promising option to adapt forests to climate change. In Central Europe, in particular Douglas-fir has been planted on large areas. The promotion of non-native tree species always carries the risk of undesired effects on native species associations. To facilitate decisions by forest managers and policy makers regarding tree species choice, we need a good understanding of effects of promoting Douglas-fir in pure stands or in mixture with native tree species on the composition and processes of associated species.
We compared diversity (species richness) and abundance of seven taxonomic groups (vascular plants, collembola, oribatida, fungi, spiders, carabid beetles and small mammals) in pure stands of Douglas-fir, European beech and Norway spruce and mixed stands of beech with either of the conifers (40 plots in total). On average, the alpha- and gamma diversity of the eight studied species groups was larger in stands with shares of either of the conifers (pure or mixed) compared with pure beech stands. No species group did have a significantly higher richness in pure beech stands compared to pure and mixed stands with conifers. Similarly, the abundances of all species groups were larger in stands with conifer shares. However, as species abundances did have a larger variance as diversity estimates, differences in abundance between stand types were mostly not statistically significant.
According to our results, enriching European beech stands with either Norway spruce or Douglas-fir mostly leads to an increase in alpha- and gamma-diversity of the studied species groups whereas abundance is largely unaffected.

06-O-11 - Eco-evolutionary feedbacks of climate on climate via the tree phenotype

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Warm climate favours particular tree phenotypes over others, and different tree phenotypes impact ambient microclimate differently. But whether climate feedbacks on climate via selection of particular tree phenotypes remains unknown. We used a 31-year-old common garden experiment on sessile oaks (*Quercus petraea*) growing descendants from provenances differing in climate and phylogenetic proximity of neighbours. We characterized tree phenotype (budburst, leaf size and shape) and extended phenotype (herbivory, mycorrhization), and measured tree temperatures on a summer day using aerial imaging by a drone. We found that descendants from provenances with mild winters had higher summer surface-temperatures in the common garden, in particular when tree neighbourhoods in these provenances were phylogenetically proximate. Effects of provenance could in part be explained by the extended phenotype of the descendant trees, notably their mycorrhizal activity. We suggest that global warming may be locally reinforced through eco-evolutionary feedbacks, and that dominant forestry practices might render this effect worse.

06-O-12 - Increasing the conservation value of tree plantings in Madagascar by the inclusion of lemur food plants and utilitarian plant species

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Tropical forests, the treasuries of biodiversity, are declining rapidly due to anthropogenic exploitation, and so is their diversity. To reverse this process, the African Forest Landscape Restoration Initiative aims to bring 100 million ha of forests under restoration by 2030. In Madagascar, tree planting is mainly based on a handful of introduced species, which can provide short-term financial benefits to people, but do not substantially contribute to biodiversity conservation.
In two approaches, we aim to improve the use of reforestation and restoration plantings for local people and animals. Starting from the animal perspective, we compiled a list of known lemur food plants, and added different characteristics inherent to these plants. The 10 most important lemur food plant species are all used by the Malagasy people in a range of activities. Starting from the human perspective, we carried out village surveys in three regions of Madagascar, to determine utilitarian plant species. 85 plant taxa of various interest to people were used by 208 different vertebrate species as habitat or food.
We suggest that including these plant species of use for people and fauna into reforestation or restoration efforts would increase their conservation potential two-fold. Firstly, people were motivated to appreciate and involve in these efforts, which would contribute to their sustainability. Secondly, animals would profit of plantings and were attracted to these. The seed dispersal of animals, such as the most important group of seed dispersers on Madagascar, the lemurs, would facilitate natural regeneration and diversify plantings. This would lower costs and time, which are primary constraints to restoration.

06-P-01 - Nitrogen addition and plant functional type independently modify soil mesofauna effects on litter decomposition in subtropical forest

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Soil fauna plays a crucial role in plant litter decomposition. However, if and how increasing nitrogen (N) deposition and plant functional type jointly affect the contribution of soil mesofauna to litter decomposition remains poorly understood. A litterbag experiment with two meshed sizes (0.1 and 2 mm) was conducted to examine the effects of soil mesofauna on litter decomposition of three coexisting functional types of trees (evergreen broadleaf, deciduous broadleaf and coniferous) differing in litter identity (6 tree litter species for each plant functional type). Litterbags were exposed to three N addition levels (0, 20 and 40 kg N ha^{-1} yr^{-1}) in a subtropical forest of southwest China. Overall, soil mesofauna significantly increased litter mass loss with the most profound effect in evergreen broadleaf litter. Further, the high N addition treatment stimulated the effects of soil mesofauna on litter decomposition, particularly in deciduous broadleaf litter. Soil mesofauna effects were positively correlated with initial leaf litter chemical characteristics, such as carbon and cellulose concentration and C/P ratio. The N effect was greater in low N than high N treatments in the 0.1 mm litterbags, but was similar in the two N addition levels in the 2 mm litterbags. Our results indicate that soil mesofauna effects on litter decomposition at low N addition are higher in evergreen broadleaf than in deciduous broadleaf and coniferous litter, and generally increase with N addition levels, particularly in deciduous litter species. The findings underscore the importance of soil mesofauna and plant functional types for litter decomposition in subtropical forests where N deposition is substantially increasing.

06-P-02 - A sequence of biotic and abiotic stressors and its effect on DOC and DN fluxes in throughfall and stemflow, and the surface pH of *Quercus rubra* saplings in a greenhouse experiment

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Drought, fire and insect infestation are predicted to increase in intensity and frequency, possibly triggering high mortality rates in forest ecosystems. Although most studies have focused on single-stress/coniferous-tree-interactions, little is known about the response of deciduous trees to stress sequences. This study focused on the simulation of drought (phase 1) followed by bark-boring damage (mechanical wounds, phase 2) accompanied by aphid infestation, and a recovery phase (phase 3) on 24 *Quercus rubra* L. (Northern red oak) saplings in a greenhouse environment. The trees were divided into stressed and control groups to study the effects on fluxes of dissolved organic carbon (DOC) and nitrogen (DN) in throughfall (TF) and stemflow (SF), and the surface pH of bark and leaves. Dissolved OC and DN play an important role in canopy, bark and soil processes.
Significant increases in weekly fluxes of DOC (2.9 g m^{-2} in TF, 1,615.1 g m^{-2} in SF) were noted for the first weeks of phase 2, which was mainly attributed to the aphid infestation and the increased contribution of honeydew derived organic C to the water cycle. High DOC fluxes were accompanied by low DN fluxes, which ranged below 0.03 g m^{-2} in TF and 8.0 g m^{-2} in SF. Solution pH of SF and bark pH was higher in stressed trees during phase 2. This highlights a strong bark-water interaction, and was attributed to the artificially-induced wounds in the bark that were assumed to bleed out nutrient-rich and more alkaline phloem sap.
Unexpectedly, both tree groups showed signs of vitality during phase 3. However, the onset of the development was time-delayed (~ 9 days) compared to control trees. Fluxes of DOC and DN in TF and SF, as well as surface pH, did not differ between stressed and control trees during phase 3. Hence, stressed saplings seemed to be resilient towards a once occurring sequence of biotic and abiotic stressors in a greenhouse environment and have the potential to regain vitality in the growing season.

06-P-03 - Response of ecosystem fluxes to the 2018 extreme drought in forest stands of the Hainich, Thuringia – a comparison between beech, maple and spruce

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Within the Collaborative Research Centre "AquaDiva", we investigated the impact of the extreme drought in 2018 on C and N fluxes in mixed beech-maple (2014) and spruce stands (2018) in the Hainich. We biweekly monitored the effect of beech, maple and spruce on ecosystem solution dynamics (open area, throughfall, stemflow, soil solutions below organic layer, 4, 16, 30 cm), on litterfall, soil temperature and moisture. All solutions were analysed for pH, dissolved organic carbon (DOC) and total nitrogen concentrations. In 2018, water deficiency of the prevailing shallow albic Luvisols led to green leaf fall and to a severe loss of vitality of beech, which resulted in a significant crown dieback. Furthermore, massive bark beetle infestation occurred in spruce stands causing a die-off in 2019/20. Annual dynamics of DOC-fluxes showed tree-species specific effects with higher fluxes under spruce, especially below the organic layer due to the accelerated litter input. N deposition to forest ecosystems averaged 10 kg $ha^{-1}*a^{-1}$ (2014-2020), with 9.2 under beech/maple and 19 kg $ha^{-1}*a^{-1}$ under spruce. Considering the impact of the 2018 drought on soil N translocation with depth, the magnitude of ecosystem disturbance becomes obvious. Compared to total dissolved N fluxes of 26 kg $ha^{-1}*a^{-1}$ (16 cm) in 2014-2016, fluxes under beech increased significantly to 164 kg $ha^{-1}*a^{-1}$ (30 cm). During the same period, maple (125 kg $ha^{-1}*a^{-1}$) and spruce (119 kg $ha^{-1}*a^{-1}$) also showed unusually high values at 30 cm. In this context, the highest 14-day fluxes were measured during winter months. The green leaf fall caused an additional N input of 1.6 kg N ha^{-1} to the soil in early August 2018, followed by higher pH values in the topsoil in autumn. This could have decisively favored microbial N transformations. Thus, increased mineralization of litter in autumn and the reduced plant N uptake during dormancy mainly influenced N dynamics after drought and enhanced the risk of N export to groundwater.

06-P-04 - Prevalence of blood parasites in a temperate forest bird community

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Ongoing environmental change and biodiversity loss pose a global challenge. Recently, novel host-parasite interactions, triggered by climate and land-use changes, have been found to accelerate the decline of host populations. While for some bird species the effects of the prevalence of blood parasites, i.e. vector-borne parasites, are known, the consequences on the community level are far from being understood. Therefore, we assessed the infection rate of blood parasites (Haemosporidians) in a bird community occupying a 250-hectare mixed forest in the vicinity of Marburg, Hesse, Germany. To do so, we captured birds following a standardised design with mist nets over three consecutive years. Then, we analysed their blood by DNA sequencing for three main genera of blood parasites, *Haemoproteus* spp., *Plasmodium* spp. and *Leucocytozoon* spp. Across 235 sampled individuals belonging to 26 bird species, 45% (106) were infected with blood parasites. First results show that infections with *Haemoproteus* spp. were most common, followed by *Leucocytozoon* spp. while only few birds were infected with *Plasmodium* spp. In a next step, we will investigate whether the prevalence of Haemosporidians follows specific pattern e.g. are linked to taxonomic relationships, foraging or migration guilds. By analysing haematological stress parameters (H/L-ratio) of each bird and considering environmental factors, such as habitat structure and availability of resources, we are expecting to better understand the impact of blood parasite prevalence on a bird community in times of environmental change.

SESSION 7

Automated Biodiversity Monitoring in Ecology

CHAIRS: ***Lars Opgenoorth, Nina Farwig, Nico Friess***

With this session we want to give a platform for presenting latest break-throughs in the automation of biodiversity monitoring by means of sensors, IoT networks, the buildup of dedicated data bases, to the automated analyses by machine learning. This can range from stationary sensors such as insect cameras, integrated tree sensor boxes, via mobile sensors mounted to animals, rovers, UAV's, to integrated biodiversity monitoring systems that cover entire interaction networks or ecosystems. We would like to hear both from recent developments and successful case studies as well as from initiatives targeting future collaborative networks.

07-O-01 - Applicability of Time-of-Flight-based cameras for an automatic long-term monitoring of sediment deposition caused by burrowing animals

Paulina Grigusova[1], Annegret Larsen[2], Diana Kraus[1], Sebastian Achilles[1], Alexander Klug[1], Robin Fischer[1], Kirstin Übernickel[3], Roland Brandl[1], Nina Farwig[1], Jörg Bendix[1]

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Burrowing animals largely influence surface microtopography through the creation of burrows and excavation of mounds. Simultaneously, microtopography significantly affects long-term sediment deposition on the hillside scale. However, the magnitudes of these impacts are still unknown. Laser scanning offers here a suitable solution for the detection of microtopographic surface changes caused by burrowing animals. One of the laser scanning methods is the Time-Of-Flight (ToF) technology in which the 3D model of an object is obtained based on the time it takes for the reflected electromagnetic waves to reach the camera sensor. To quantify microtopographic surface changes on a long-term basis, continuous data retrieval at a high resolution and a precise quantification of the deposited sediment is needed.
Here, we tested the applicability of the ToF-based cameras for an automatic cost-effective long-term monitoring of the microtopographic surface changes and the ability of the cameras to quantify the volume of the deposited sediment. We integrated the cameras into a self-developed installation which allows a low cost (approx. 1000 €/camera) high spatial resolution (5.8 - 6.1 mm) continuous monitoring of the surface at regular intervals of four frames per day. We tested our set-up in the field at 8 remote locations within two climate zones of Chile (arid and mediterranean) for a period of seven months with regard to installation stability, data availability and data quality. Lastly, we calculated the daily sediment deposition for the areas influenced by burrowing animals and control areas.
The ToF-based cameras were able to detect sediment deposition with a mean absolute error of 67 cm^3/m^3 sediment volume. Long-term automated monitoring in the field was tested with a good data reliability as six out of eight cameras provided data in regular intervals for the whole period of 7 months and one camera for a period of 4 months. The detected sediment deposition rate was higher within areas affected by burrowing animals than the control areas. Overall, this study shows that ToF-technology can be used for an automatically running long-term monitoring of sediment deposition by integrating it into a simple and low-cost set up. The surface changes can be detected at a very high-resolution and enable quantification of the eroded sediment volume.

07-O-02 - Principles and applicability of TreeTalker, TT+: a two-needle transient thermal dissipation with capacitive sensor enabling real time sap flux density and stem water content measurements

***Shahla Asgharinia*[1]**

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Application of IoT technologies represents a novel low cost and efficient tool for studies across many disciplines. Here, IoT applied to plant ecophysiology and hydrology aims to unravel the vulnerability of an ecosystem to climatic stress via single tree assessment. Taking advantage of established IoT tech, a new multifunctional device, the “TreeTalker”, was developed to monitor real time physical and biological parameters at single tree scale as well as some additional ecosystem-related variables. Key parameters are: 1) tree radial growth, as an indicator of photosynthetic carbon allocation in biomass; 2) sap flux density, as an indicator of tree transpiration and functionality of xylem transport; 3) stem water content as indicator of hydraulic functionality 4) light penetration in the canopy in terms of fractional absorbed radiation 5) light spectral components related to foliage dieback and physiology and 6) tree stability parameters to allow real time forecast of potential tree fall.
The focus of this study is to represent the performance of the TreeTalker in relation to its capability to measure stem water content and water transport in trees. The novel TreeTalker is designed to utilize the transient thermal dissipation (TTD) method for sap flux determination and a capacitance sensor to measure stem water content.
The results show that the range of stem water content registered is highly influenced by seasonal variability of climate conditions and with minor influence from local conditions in the same species. Stem water content constitutes a significant portion of the daily transpiration. By employing TT+ and revisiting different thermal approaches, it was confirmed that the best possible empirical approach is a transient regime using cooling phase data to value the thermal index “K”. Overall, the TreeTalker demonstrated the potential of autonomous devices for monitoring relative stem water content and sap flux density in the field of plant ecophysiology and hydrology.

07-O-03 - Principles and applicability of IOT for forest measurement TT+: IR and Magnetic sensors for measuring stem radial increment

***Jim Yates*[1]**

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Sensor integrated IoT platforms such as the 'TreeTalker' are emerging as novel systems for forest monitoring, capturing tree eco-physiological responses to abiotic and biotic stress in real time. Focusing on stem radial growth here, changes in stem inter and intra annual increment via non-invasive, cost-effective and real-time sensor technology offers potentially improved insights into the drivers of tree physiological stem increment in response to management interventions, natural disturbance, and climatic stress.

The focus of this study is to develop, test and apply novel dendrometry sensors for the detection of changes in stem radial increment at higher resolutions than established conventional measurements, depending on the sensor type, associated instrument error and subsequent environmental sensitivity. Selection and application of an infrared distance measuring sensor and a contactless high resolution magnetic linear encoder are tested under controlled conditions. Associated measurements are captured via Arduino and Treetalker micro controllers, respectively. Linear calibration using digital calipers with incremental steps dependent on sensor type are performed. For the infrared sensor type, target surface, temperature and light tests were conducted. For the magnetic linear encoder, temperature only was performed.

Initial results indicate both sensors perform well under controlled lab conditions, both having different associated errors and resolutions. Field tests of the infrared sensor demonstrate, in principle, its ability for detecting changes in stem radial increment over time, however evidence of temperature impacts on sensor signal and oscillation is evident, while the magnetic sensor is still in the development and laboratory test phase. Future applications of such sensors are aimed at integration with individual based methods for tree and forest simulation. Improvements in sensor housings are required.

07-O-04 - Advances in open-source sensor development for the observation of movement and behavior of bats

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Bats represent a highly diverse group of mammals and are essential for ecosystem functioning. However, knowledge about their behavior, ecology, and conservation status is limited. One possible reason is, that popular observation methods such as camera traps and conventional tracking technologies cannot sufficiently capture the behavior or movements of individuals. Here we present two low-cost and open-source systems facilitating the observation of bats with possible integration into automated biodiversity monitoring systems.

The tRackIt system is an automatic radio-tracking system. Manual radio telemetry has disadvantages including labor intensity, low temporal and spatial resolution, infrequent and irregularly timed locations and small sample sizes. The quality of the resulting data also precludes any advanced analytical techniques created for fine-scale tracking data. tRackIT provides a high temporal and spatial resolution and works with inexpensive consumer electronics, flexible antenna designs and user-friendly, open-source software.

The BatRack is an modular multi-sensor observation system that integrates audio, video and automatic radio-tracking in a single unit. Video recordings are often used to observe the behavior of individuals, but fail for small species. Acoustic signals, with their comparatively long range, can serve as triggers for visual sensors. Additionally to a long range and the resulting control over triggering distance, VHF-signals enable the recognition of individuals in video recordings. The three recording technologies can be used separately, simultaneously, or in mutual trigger mode, and the corresponding configuration scheduled and switched automatically.

In two linked case studies, we show how the more local BatRack technology can provide insights into specific behaviours of difficult-to-observe animals, and how these local observations can serve as ground truth for the classification of data recorded with the long range tRackIT stations.

07-O-05 - Towards automated bird censuses using spatially distributed sensors and artificial intelligence - a comparison with real world community data

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Nature conservation management requires detailed information on ecosystems and the species living therein, which is often time- and cost-intensive. Recent developments in sensor technology allow the deployment of automated recording units in the field to record soundscapes of entire ecosystems. Advancements in machine learning algorithms enable the identification of different species based on vocalization recordings. In combination with spatially distributed sensors, this allows conclusions about the spatiotemporal occurrence of target species in a study area. These high-resolution datasets can be used for the continuous monitoring of protected species across taxonomic groups and may facilitate targeted conservation measures. Birds are well suited for automated monitoring approaches because their vocalizations enable the identification of species, breeding status and even age. However, comparisons between the monitoring success through sensor networks and actual census data collected from the field remain challenging. We conducted an area wide breeding bird census from spring to early summer in two consecutive years for ground truthing. Audio recordings were collected in parallel with the bird census at 48 locations in the Marburg Open Forest, Germany. We constructed a neural network for the automated identification of bird species in which publicly available sound libraries along with recordings from our study area were included. Using our own as well as published pre-trained models we determined the spatiotemporal occurrence of ~ 50 bird species present in the study area and compared the results with our bird census from the same forest. Our preliminary results show a promising match of the neural network with real world community data. Similar vocalizations and imitations were reliably audio-visually identified by experts in the field, while the networks succeeded in the monitoring of cryptic or nocturnal species.

07-O-06 - Detection of meadow breeding birds using UAVs and thermal image camera with disturbance analysis measuring the heartbeat-rate

***Tom Wulf*[1]*, Dae Yong Kim*[1]*, Lars Huth*[1]*, Matthias Pietsch*[1]**

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Today, most meadow-breeding birds are endangered due to mowing. The detection of their nests with the help of UAVs (unmanned aerial vehicles) promises less effort and disturbance and can be integrated into (semi-) automated processes (e. g. Santangeli et al. 2020). However, there are considerable uncertainties concerning the disturbance of the breeding birds.

This study proposes an approach and presents first results on the detection of meadow breeding birds with UAVs and thermal image camera with different settings. In addition, how the effects of disturbance caused by UAVs can be measured at breeding-bird sites on cultivated pastures.

During the research project „FHprofUnt 2018: Farming 4.0 im Grünland“, the detection of breeding birds or nests of the Eurasian Curlew (*Numenius arquata*) and Northern Lapwing (*Vanellus vanellus*) were tested using different flight altitudes, UAV-models and sensors in different habitats and daytimes. The effects of disturbance by UAVs were investigated during such flights, by measuring the heartbeat-rate (e. g. Hüppop & Hagen 1990). In addition, the heartbeat-rate response caused by raptors flying over and other disturbances was measured. The results show that different flight levels and sensor types of the UAV can cause different results on how the nests are detectable during different daytimes. Also, the increased heart-rates measured as a reaction to UAVs differ along flight altitudes but are comparable with responses to natural events like raptors flying over.

In the course of this project, further birds will be studied to increase the significance of the results.

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07-O-07 - Automated plant cover prediction with convolutional neural networks

Matthias Körschens[1], Solveig Franziska Bucher[1,3], Paul Bodesheim[1], Joachim Denzler[1,2,3,4], Josephine Ulrich[1], Christine Römermann[1,2,3]

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Analyzing changes in the composition of plant communities in response to changes in environmental conditions is an essential task in plant ecology research. This is usually done by manually identifying the plant species and then estimating the plant cover in vegetation plots. However, this identification and estimation is quite laborious and can differ from one person to another. Therefore, automating this task based on image data would be advantageous. This would not only enable a more objective analysis of the plant composition but also generate estimates in a high temporal resolution, as pictures can easily be taken once a day via automated camera setups.
Here, we propose an approach using convolutional neural networks (CNNs) to identify species and analyze the plant cover in images of vegetation plots in a fully automatic way. However, while deep learning models like CNNs are suitable for such an automatic analysis, training networks merely on images of vegetation plots does not usually yield satisfying results due to the complexity of the plant cover images. To improve this situation, the usage of additional external images, such as plant images from the web, can improve the network's performance. Hence, our system also incorporates images from external sources to improve plant identification and cover prediction. To this end, it converts imagery with available species data into segmentation data in a fully automated way, enabling a more efficient utilization of the available images.
In the future, we will develop an open-access application, where pictures from vegetation plots can be uploaded, and the identified species together with their plant cover will be returned. The system is developed in an interdisciplinary cooperation between biologists and computer scientists.

07-O-08 - Geo Engine: Data fusion inside your data portal

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Geo Engine is a spatio-temporal geoprocessing platform that supports users and organizations to easily explore, visualize and analyze their geographical data. It has advanced capabilities in integrating heterogeneous data, for instance, from biodiversity observations and remote sensing. Moreover, Geo Engine natively treats all data as time series, which makes it a suitable data fusion system for the seamless handling of spatio-temporal data.
Geo Engine is accessible in various ways: via a RESTful API, a Python package, and a powerful web-based user interface. The web interface is modular and easily customizable for tailor-made geodata platforms. These range from GIS-like UIs for power users like data scientists to lightweight dashboards for non-experts or decision-makers. Thus, the powerful functionality can be fitted perfectly to the needs of individual user communities while providing lots of options for further advancements like, for instance, new processing capabilities and analytical charts. In addition, the backend can be extended using external data providers. This particularly supports a flexible inclusion of arbitrary remote data sources, e.g., public and project-specific data sources.
In this talk, we give an overview of Geo Engine and show a selection of data portals that are built upon Geo Engine. In more detail, we present a use case of the LOEWE Nature 4.0 project, in which we combine project data from sensors and observations with external remote sensing data from ESA's Sentinel 2 satellite. In addition, we introduce Geo Engine's capabilities to define workflows for data processing in an ad-hoc manner, share these workflows among users, and access their results via standardized OGC interfaces. In summary, Geo Engine is a powerful platform for implementing flexible data portals, providing rich data fusion and access capabilities based on the FAIR principles.

07-P-01 - An automated light trap for nocturnal insect monitoring using off-the-shelf components and utilizing open-source software

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Classically, monitoring of nocturnal insects involves catchments with light traps where the insects are killed for later determination. Such invasive methods, albeit most likely unproblematic when applied for single nights, might pose serious threats to moth communities when applied over longer periods at the same sites. However, recent reports on large scale insect decline underline the need for more long-term datasets on insects. Automatic moth traps (AMT) might provide non-invasive means of generating these much-needed datasets. Most designs of AMTs (e.g. Bjerge et al. 2021) involve a light source attractant to nocturnal insects and a camera that makes photographs of the insects for later quantification. Here, we present the design for an AMT that consists of off-the-shelf hardware that is readily available, easy to assemble and robust to moisture. Moreover, we developed a software which enables the user to deploy the units with individual time schedules controlling the light regime, which not only allows for a broader range of research questions, but which also allows for both a reduction in energy expenditure as well as disturbance for non-target animals. We present preliminary results of a field comparison of AMTs and conventional light traps and highlight future applications of the units.

07-P-02 - BioDetect: automated image processing for ecological monitoring

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Biodiversity is declining worldwide at an alarming rate, and our ability to gather critical data from ecosystems has not kept pace. Advances in computer vision and machine learning promise to revolutionize ecological visual data collection by automating the process, but tools ready to be applied to real-world biological scenarios are still lacking. We are developing computer vision methods to help bridge this gap.

Our approach relies on deep-learning detection algorithms, that will automate the process of extracting and classify video frames from field monitoring camera traps. We first focus on hummingbird-plant interaction data from South America.

We use convolutional neural networks (e.g. ResNet50) and finetune them for binary classification tasks ("bird", "no bird"), while forcing the model to respect temporal smoothness along frames. Our goal is to train this model on a database of annotated still frames, and apply it on a variety of biological monitoring videos to make it a robust general solution for the detection of visitors to focal items (i.e. flowers, nests) in visually cluttered environments.

This algorithm will be part of a modular system, where different components will perform each a specific function that seamlessly fit together in an integrated pipeline. Such an approach allows to replace and separately train components depending on the task. Next steps include: a classification algorithm that can predict hummingbird species identity; an instance segmentation algorithm that will aid in the sorting and counting of digitized mixed-species aquatic invertebrate samples; a phenotyping algorithm that will extract morphological trait distributions from segmented images and eventually suggest a taxonomic placement based on multivariate trait clustering.

By developing modular tools using the latest technology, we hope to aid the ecological community in tackling biodiversity visual monitoring with more and better data.

SESSION 8

Incorporating Multiple Functions and Services of Grassland Ecosystems to Advance Conservation Strategies for Modern Societal Demands

CHAIRS: ***Gert Rosenthal, Nils Stanik, Eckhard Jedicke***

Grasslands of high nature value (HNV) fulfil multiple ecosystem functions and provide several ecosystem services. The variety of different functions and services developed out of a long history of diverse management systems, which generated at the same time the high biodiversity of these ecosystems. Even if many grassland ecosystems are subject of national and/or transnational protection schemes, they experience a continuous qualitative and quantitative decline throughout Europe. Major causes for this trend are that the economic interest and motivation for maintaining these ecosystems decreased in favour of high-productive grasslands. In the past small-scale agricultural context, production of biomass was the targeted ecosystem service by farmers for all grassland types, whereas today other ecosystem services like their regulating services (e.g., carbon sequestration) or cultural services (e.g., their aesthetic value) gain increasingly a broad societal recognition. Therefore, one can assume that the consideration of multiple ecosystem functions and services would support and enhance conservation efforts of HNV grasslands as an important ecological, economic, and aesthetic resource against mono-functional highly productive grasslands of low biodiversity. The session's approach is to combine aspects from science and practice to advance conservation strategies for grasslands and linked taxonomic groups. We call for contributions that preferably consider both grassland's multiple ecosystem functions and services, and their societal significance. The aim is to summarise scientific evidence on the multiple dimensions of ecosystem functions and services of HNV grasslands and develop this information for modern societal demands. Furthermore, we want to discuss these results in the light of current and future conservation goals. Here, main questions are: (i) How are different facets of biodiversity linked to ecosystem functioning and service provision of HNV grasslands?, (ii) What biotic and abiotic processes, species (groups), and traits are a prerequisite that contribute to grassland's ecosystem functions and services?, (iii) What role takes the grassland management in achieving multifunctionality and supporting multiple ecosystem services? and (iv.) How can that support and advance more targeted conservation schemes and activities on HNV grasslands to generate diverse benefits to the society? This would be an important step forward to generate benefits and to transfer knowledge into management practice and current political discussions. The session corresponds to a Special Feature organised in the journal Basic and Applied Ecology (submission deadline currently planned for Sept. 2021), for which we want to encourage the contributors to submit a paper based on their sessions contribution. For questions about the Special Feature, please contact the session organisers.

08-O-01 - Considering multiple ecosystem functions and services of grasslands: A key to support and advance grasslands conservation?

Gert Rosenthal[1], Nils Stanik[1], Eckhard Jedicke[2]

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Grasslands of high nature value have been on steady decline for the last decades. A focus on mono-functional grasslands to produce biomass has led to a substantial decline of biodiversity linked to grasslands. Therefore, one can assume that the consideration of multiple ecosystem functions and services of grasslands would support and advance conservation strategies and efforts and would highlight grasslands as an important ecological, economic, and aesthetic resource for modern society. In this introduction of the session, we want to provide the background and present emerging issues of the session's topic.

08-O-02 - Ant community composition and functional traits in new grassland strips within agricultural landscapes

Victor S. Scharnhorst[1], Konrad Fiedler[2], Thomas Frank[1], Dietmar Moser[2], Dominik Rabl[1,2], Manuela Brandl[1], Raja Imran Hussain[1], Ronnie Walcher[1], Bea Maas[1,2]

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Ongoing intensification and fragmentation of European agricultural landscapes dramatically reduce biodiversity and associated functions. Enhancing perennial non-crop areas holds great potential to support ecosystem services such as ant mediated pest control. To study the potential of newly established grassland strips to enhance ant diversity and associated functions, we used hand collection data and predation experiments to investigate differences in (a) ant community composition (b) biocontrol related functional traits, and (c) natural pest control across habitats in cereal fields, old grasslands, and new grassland transects of three years age. Ant species diversity was similar between new and old grasslands, but significantly higher in new grasslands than in surrounding cereal fields. Contrary, ant community composition of new grasslands was more similar to cereal fields and distinct from the species-pool of old grasslands. The functional trait space covered by the ant communities showed the same distribution between old and new grasslands. Pest control did not differ significantly between habitat types, and therefore could not be linked to the prevalence of functional ant traits related to biocontrol services in new grasslands. Our findings show trends of convergence between old and new grasslands, but also indicate that enhancing ant diversity through new grasslands takes longer than three years to provide comparable biodiversity and functionality. Three years after their establishment, new grasslands were still dominated by common agrobiont ant species and lacked habitat specialists present in old grasslands, which require a constant supply of food resources and long colony establishment times. New grasslands represent a promising measure for enhancing agricultural landscapes but must be preserved in the longer term to promote biodiversity and resilience of associated ecosystem services.

08-O-03 - Habitat quality assessment of meadows for parasitoid Hymenoptera

Maximilian Sittinger[1], Annette Herz[1]

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Parasitoid Hymenoptera are one of the most important functional groups providing biological control in agriculture. Due to their high trophic position and close interactions with many insect species, the abundance and diversity of parasitoids is highly dependent on the occurrence of potential hosts. Together with their often restricted mobility due to small body sizes, this makes their populations sensitive to land use change and agricultural management intensity. Permanent agricultural grasslands account for nearly one third of the total arable land in Germany, thus belonging to the most important refuge habitats for insects. Especially extensively managed meadows can be an important source of pollen and nectar for many insect species like most adult parasitoids. As part of the project MonViA, we monitored parasitoids in meadows differing in management intensity. MonViA is a joint project between the Thünen Institute (TI), JKI and the IBV of the BLE, funded by the BMEL. Complementary trapping systems (emergence traps, yellow pan traps, sweep net, suction sampler) were deployed on 16 hay meadows in southern Hessen during the years 2019 and 2020. In each month from March to October, at least one of the trapping systems was in action. Soil emergence traps were applied to catch arthropods emerging from a specific area during spring to assess overwintering habitat quality. In total more than 3500 individual parasitoids were caught, mainly belonging to Chalcidoidea and Platygastridae. Land use intensity had a significant effect, with more than twice as much parasitoids emerging from extensive meadows compared to intensive ones. We are developing a workflow to automatically count and classify flowers in UAV pictures taken of the meadows with deep learning models. This method could yield a precise estimation of flower abundance/cover. Thereby, we want to explore the relationship between flower cover and occurrence of parasitoids and other functional groups more efficiently.

08-O-04 - The role of functionally rare species for ecosystem processes in mesophilic grasslands - lessons learnt from a long term experiment

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Land use changes cause a tremendous loss of species richness and functional diversity, leading to reduced ecosystem processes such as biomass production. Functionally rare species (rare species with unique functional trait attributes) only represent a small proportion of biomass by definition. Yet, we expect these species to have a significant effect on ecosystem functioning as they extend the community trait space and therefore increase functional diversity. Here, we investigate how different land use intensities affect the occurrence of functionally rare species on the one hand and analyse the importance of functionally rare species for biomass production on the other hand.
After a brief introduction to the concept of functional rarity, we apply this concept to vegetation data from a long-term experiment of 17 years, covering a broad land use intensity gradient (mowing four and three times + fertilisation, mowing twice, mulching once, abandonment) in a mesophilic grassland. We investigate the role of functionally rare species and their traits for biomass production and compare the outcome to the importance of overall species richness for biomass production. With our research we contribute to a better understanding of how different facets of biodiversity affect ecosystem functioning in species rich mesophilic grasslands, representing a threatened habitat in the Central European landscape.

08-O-05 - Biogeography can be more important than land management in shaping biotic above- and below-ground communities

Eleonore Slabbert[1,2], Tiffany Knight[1,2,3], Tesfaye Wubert[1,3], Antje Kautzner[1], Cornelia Beassler[1], Harald Auge[1,3], Christiane Roscher[3,4], Oliver Schweiger[1]

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Ecological consequences of land management (LM) result in a direct loss of natural habitat and shaping different components of above- and below-ground biodiversity. Our study takes a detailed investigation of what shapes communities in semi-natural grasslands under long-term management as either pastures or meadows. We hypothesise that despite the role of biogeographical conditions as initial environmental filters, local above- (plant) and belowground (fungi) communities are presently stronger influenced by current and historic land management (LM) and land use intensity (LUI).
To address this question, we investigated the relative importance of land use (LM and LUI) and biogeographical conditions (local weather, topography, soil) across 5 study sites in Central Germany in explaining occurrence patterns of plants and soil fungi. Analyses included a hierarchical joint-species distribution modeling approach to uncover the role of possible drivers shaping the local communities. Additionally, we investigating the effect size and direction of land use and biogeographical variables for specific functional groups in more detail.
Our results show biogeographical variables for both the plant and fungi species are of particularly high importance compared to land use. In general, the relative importance of explanatory variables was similar across both taxa groups, however, for plants local weather conditions were more important, while for fungi the soil variables played a more prominent role. Only at a detailed level of the results was there a significant response to LM and LUI for nearly half of the plant and fungi species. Our findings provide more insight on the complexity of ecological processes within managed systems, aiding further research and policy recommendations for conserving multitrophic diversity within agroecosystems.

08-O-06 - Plant diversity effects on multitrophic ecosystem functions depend on network contexts and diversity facets

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The strength and even sign of biodiversity-ecosystem functioning (BEF) relationships vary substantially in grasslands, potentially depending on the diversity facets (e.g., species richness or functional composition) and the ecosystem functions investigated. Variability is particularly high when considering complex multitrophic communities, because BEF relationships may depend on trophic-network contexts, such as trophic group, or dimension of ecosystem function (standing stocks vs. energy flows). Such uncertainties limit our ability to translate BEF results to grassland management and conservation. We tested how the effects of grassland plant communities on biomass stocks and energy flows of each trophic group depend on their location in the trophic network and plant diversity facets (species richness, number and presences of functional groups) using data on coupled above-belowground multitrophic networks of energy dynamics assembled for 80 grassland plots of the Jena Experiment. Specifically, we compared the strengths of diversity effects between trophic groups, trophic levels, above- (AG) vs belowground (BG) subnetworks, and groups of ecosystem functions. Plant species richness and legume presence were the most influential drivers of multitrophic ecosystem energetics. Some trophic groups (e.g., AG herbivores and carnivores) showed contrasting responses of their stocks and flows to diversity facets. This indicates that plant diversity losses constrain consumer functioning by means other than simply altered standing biomass. Further, responses of flows and stocks to diversity facets differed between trophic groups, levels, and AG relative to BG parts. Our results highlight the importance to study the individual BEF relationships for a comprehensive multitrophic understanding, and suggest that grassland management should focus on specific combinations of diversity facets depending on the ecosystem function and trophic level at risk or ecosystem services of interest.

08-O-07 - Trade-offs between ecosystem functions vary depending on year, season, and identity of ecosystem functions

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Often land-use aims at providing many ecosystem services at the same time. However, multifunctionality can be limited by trade-offs and be enhanced by synergies between the underlying ecosystem functions (EF). Understanding such trade-offs is essential for the development of targeted management. Observed relationships between EFs vary between studies resulting from differences in the assessment of EFs but also due to natural variability in the relationship between EFs. We hypothesized, that relationships among EFs are highly variable, even under controlled conditions such as in experimental studies. To test this hypothesis, we used data on 24 EFs that were measured up to 4 times per year, for 5 to 17 years in a grassland experiment with 80 different plant communities. We analysed the variability of EF-relationships and evaluated the influence of season, year, and community composition on the EF-relationship. The community composition explained most of the covariance between individual EFs (50 %), while year (16.1 %), and season (9.4 %) together explained only 1/4 of the covariance. 14.2 % of covariance between EFs remained unexplained. Average correlations between pairs of EFs ranged from -0.9 to 0.86. Most EF-pairs (147) showed no correlation (-0.3 to 0.3), many EF-pairs (51) showed weak (|0.3 to 0.5|), 21 showed moderate (|0.5 to 0.7|) and 10 EF-pairs showed a strong positive or negative correlation (> 0.7 or < -0.7). All relationships were highly variable over replicated measurements, even EF-pairs with a weak average correlation showed high variability. Our results emphasize, that EF-relationships based on single snapshots in time can be highly misleading, because of high variability in these relationships. When developing management strategies for multifunctional ecosystems, this variability needs to be recognized and reliable thresholds, mechanistic limitations, and common drivers of EFs must be identified based on replicated measurements.

08-O-08 - Provision of multiple ecosystem services in extensively and intensively managed organic and conventional grasslands in Switzerland

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Besides potentially harboring high levels of biodiversity, grasslands can provide a wide range of provisioning, regulating, supporting and cultural ecosystem services (ES) essential for human wellbeing. Management intensity is likely to be a major factor influencing to what extent a grassland can provide a high number of ES, i.e. high ES-multifunctionality. Here, high-intensity management aims at optimizing the provisioning ES – potentially at the cost of regulating, supporting and cultural ES. Government payments for extensively managed meadows and pastures, as implemented in Switzerland, could thus potentially benefit grassland ES-multifunctionality. We investigate this question by measuring 19 ES on 94 grassland sites managed by 36 different organic or conventional farmers in Switzerland. These grasslands are meadows and pastures managed extensively or intensively. This full-factorial study design allows for insights into which management strategy can promote which single ES and which can yield the highest ES-multifunctionality. So far, besides assessing plant and soil microbial diversity, seven soil functions related to the ES decomposition and fixing processes, climate regulation, control of erosion rates and freshwater quality have been analyzed. The results do not indicate differences between organic and conventional management but show differences in ES-provision between extensively and intensively managed grasslands, with extensive pastures providing the highest level of ES-multifunctionality –regarding the ES measured so far–compared to the other grassland types. Thus, the results suggest that agricultural subsidies for extensive management indeed have the potential to promote ES-provisioning to the society, besides supporting biodiversity conservation.

SESSION 9

Scales and Heterogeneity in Ecology

CHAIRS: ***Katrin M. Meyer, Kerstin Wiegand, Britta Tietjen***

Scale-dependence is ubiquitous in ecology. It adds a new dimension of complexity to ecological research which calls for more scale-explicitness. However, scale-explicit studies and specifically general scaling methods are still scarce. This applies to empirical and modelling studies alike. In the case of homogeneous study sites, linear methods can often be used for scaling-up. However, our world is inherently heterogeneous, which makes connecting multiple scales highly challenging. The problems start with matching the study findings to the research question and do not end with transferring ecological patterns across spatial scales of a heterogeneous environment. The goal of this session is to contribute towards resolving this scale discrepancy in ecology.

09-O-01 - Separation of time scales: relevant in ecology?

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The separation of time scales is a long-known phenomenon in physics. It describes that in systems with fast and slow processes, the fast processes often assume stationary dynamics quite quickly with respect to the time scale of the slow process. In physics, this has been used to simplify mathematical models. There are also first examples in ecological modeling. I will present an example where the separation of the behavioral and demographic time scales was used to determine demographic parameters without running the full simulation model over hundreds of years. I will discuss how time scale separation has been used in other disciplines and fields, such as hydrology and forest modeling, and finally outline the concept of "transfer functions", that has been jointly developed by modellers and monitoring experts from ecology, hydrology, and the geosciences at the UFZ. It helps preserve the essence of fast processes at small spatial scales while allowing models to be (1) parameterized for large regions and (2) to be transferred to new regions without complete recalibration.

09-O-02 - Upscaling plant community dynamics from the individual to the community scale

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Transporting critical information across scales is one of the major issues in ecology. For example, many studies suggest that spatial patterns such as intraspecific clustering and interspecific segregation, which emerge from neighbourhood effects occurring at the "microscopic" scale of individual plants, may play an important role in diversity maintenance of plant communities at a "macroscopic" scale. However, it is unclear how to integrate the emerging spatial patterns into macroscopic theory.
Here I propose an upscaling approach that incorporates the essence of pattern-forming processes operating at the level of individuals and translates these by means of spatial transfer functions into macroscopic models of community dynamics. As point of departure I use Lotka-Volterra style models of forest dynamics and derive transfer functions for the population-level interaction coefficients α_{ij} to be dependent on individual-level interaction coefficients β_{ij} and indices of the emerging spatial patterns. Information gathered from fully stem-mapped data of plant communities together with assumptions on local density dependent competition allows determination of the functional form of these indices and their snap-shot values.
Individual-based simulations can be used to determine the values and dynamics of the indices of spatial patterns and their associated level of stochasticity. A macroscopic models that incorporates the transfer functions is a "models of a model" that approximates the detailed underlying individual-based model, and pattern-oriented modelling allows fitting the model to fully stem-mapped data. The proposed framework allows for studying the role of pattern-generating microscopic mechanisms and processes on community dynamics and stability, and the up-scaled macroscale model can be used as one pixel in a large-scale metacommunity model to cross three hierarchical spatial scales.

09-O-03 - Mapping biodiversity changes across a continuum of spatio-temporal scales

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Global biodiversity is facing increasing anthropogenic pressures. Being at the basis of many ecosystem services, it is important to document and understand its temporal trend. However, as an extensive variable, biodiversity and its dynamic are defined by both spatial and temporal scales that are closely related. While the links of biodiversity to area and time span are well known (i.e. species-area relationship, species-time relationship), it is still not clear how temporal changes of biodiversity are linked to spatial and temporal scaling. For instance, even though global biodiversity is declining, we do not always observe this decrease at local or regional scales. Here, we empirically document these relationships between biodiversity temporal trends and spatio-temporal scales (grains). we used high-quality spatially and temporally heterogeneous data on bird diversity from the Czech Republic: a first atlas dataset that embeds the highest spatial and temporal scales and a second one composed of local time series with high spatial and temporal resolution. we found that avian species richness changes through time are negative at small spatial grains but positive at larger grains, showing that the intensity of macroecological processes vary with spatial scaling. we also found that species richness reaches a plateau with increasing temporal scale allowing inference of an optimal census time. In addition, we propose to use machine learning approaches (*e.g.* random forest) to predict biodiversity across a continuum of spatial and temporal scales. This will allow to predict biodiversity changes for locations and spatial and temporal scales which have not been sampled. Together with the unprecedented biodiversity data, these machine learning methods will show the link between species richness and spatio-temporal scales. These findings will be informative for estimation of biodiversity trends in data-poor regions.

09-O-04 - Drivers of resource specialization vary across spatial and temporal scales

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Network specialization promotes diversity and resilience. However, identifying general mechanisms influencing specialization in mutualistic networks has been difficult, partly because of the different spatial and temporal scales considered. Spatial analyses comparing networks across gradients have used temporally aggregated data, limiting our ability to identify ecological mechanisms that occur over short time scales. Temporal dynamics often are evaluated at single or few sites, making it difficult to assess how differences in abiotic and biotic factors influence specialization. Thus, teasing apart the relative importance of different mechanisms requires a spatial and temporal multiscale analysis. At 11 sites along an elevation gradient in Ecuador, we recorded 29,384 interactions between 147 plants and 30 hummingbirds over 2 years. We also measured traits related to foraging ecology in both flowers and birds. We found that variables significantly related to specialization were different for spatial and spatial-temporal scales. Across space, resource abundance contributed to hummingbird foraging specialization but only in assemblages where resources were functionally diverse. When considering our fine temporal scale (monthly samples), we found that the number of co-occurring hummingbirds and their functional similarity affected specialization. This work highlights the importance of considering different spatial and temporal scales and both species and functional diversity to understand the variability of mechanisms influencing community specialization.

09-O-05 - Upscaling in socio-environmental systems modelling: Current challenges, promising strategies and insights from ecology

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Sustainability challenges in socio-environmental systems (SES) are inherently multiscale, with global change emerging from processes that operate across different spatial, temporal as well as organizational scales. To adequately understand SES, models of SES need to incorporate multiple scales, which requires both adequate representation of relevant processes at different scales and sound methodologies for transferring information between scales. Due to the cross-scale nature and the increasing global connectivity of SES, *upscaling* – increasing the extent or decreasing the resolution of a modelling study – is becoming progressively more important. However, upscaling in SES models has received less attention than in other fields such as ecology or hydrology and therefore remains a pressing challenge.
To advance the understanding of upscaling in SES, we review upscaling approaches in different disciplines and present an approach to facilitate the transfer of existing upscaling methods to SES. To better describe and compare these methods, we propose a scheme of five general upscaling strategies that builds upon and unifies several existing schemes. The scheme's main purpose is to provide a standardized way of classifying and describing upscaling methods and, by that, facilitating the comparison as well as transfer of upscaling methods to a new context. We demonstrate how this scheme can be applied, using two upscaling examples from ecology and show how these could be transferred to a hypothetical SES context. Here, our scheme allows us to obtain a better understanding of the upscaling methods used, in particular the objects that have been scaled and the functional relationships used in the scaling process. To make upscaling methods more accessible to other users and modelers, we suggest that authors should provide a standardized and transparent description of upscaling steps and strategies used, for which our scheme can provide a starting point.

09-O-06 - Forest management, biodiversity and ecosystem functions - to what extent are these relationships scale-dependent?

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Land-use change and intensification are a major driver of biodiversity loss. However, it is less clear whether and to what extend the effects of land use on different facets of biodiversity depend on the spatial scale considered. Here I ask whether (1) forest management differentially affects abundance, diversity (α and β) and associated ecosystem processes (herbivory) in the canopy and understory? (2) management systems operating at different spatial scales affect diversity at different levels (α, β, γ)? (3) are species filtered through management at different spatial scales depending on their traits? The results presented show that responses of communities and processes depend on the vertical strata. Furthermore, among stand heterogeneity was shown to be an important driver of regional diversity. These scale-dependent effects are caused by different management-related filters related to habitat characteristics and connectivity. Isolation and microhabitat properties may play a role at different spatial scales, making general predictions of the consequences of forest management difficult. Nevertheless scale-dependent effects need to be considered in management and conservation strategies aimed at maintaining or promoting biodiversity.

09-O-07 - Contrasting patterns of functional diversity and similarity of bird communities in tropical agroforests

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Wildlife-friendly management strategies for tropical agroforests have been driven by evidence of bird diversity declining with increasing distance to primary forests. However, they have often ignored potential contrasts in bird diversity patterns within a country contingent on the region. Not accounting for this heterogeneity may lead to mistaken large-scale conclusions about biodiversity in agroecosystems. We studied bird communities in Peruvian cacao agroforests and nearby forests in two regions with contrasting forest types: tropical dry forests in Piura and subtropical wet forests in Cusco. These regions share a strong climatic seasonality, but diverge largely in their vegetation structure and composition. We calculated beta-diversity indices and their turnover and nestedness components, and assessed how they varied along a gradient of distance to forest. Bird communities in subtropical forests had higher dissimilarity due to turnover, indicating large species replacement. In contrast, beta diversity increased with forest distance only in dry forests, due to an increase in nestedness (from ca. 0.05 to ca. 0.2), indicating species loss. We also assessed if functional diversity and key bird functional traits changed with forest distance and between regions. In both regions we found that functional richness decreased around 50 % with distance to forest, while functional evenness increased. This indicates that bird communities far from forest were dominated by fewer species with similar functional traits. These patterns were consistent in both regions, but the decrease in bird functional traits was stronger in subtropical forests. This first comparison between tropical regions with different forest types highlight the risk of generalized conservation strategies for cacao agroforestry which may fail to protect the most locally-threatened species and ecological functions. Regionally-adapted conservation strategies are urgent: In our tropical dry forest wildlife-friendly agroforestry should improve the connection with forests to prevent overall species loss in cacao agroforests. In contrast, conservation efforts in our subtropical wet forests should combine forest protection with direct improvements of vegetation diversity inside agroforests, with a focus on resources for insectivorous birds and canopy foragers to guarantee the maintenance of irreplaceable ecosystem services related to these birds.

09-O-08 - Wild bee assemblages on wildflower strips: Data resolution and spatial scale are key to disentangling effects of landscape structure and agricultural practices

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Perennial wildflower strips are widely implemented as agri-environmental measure to provide wild bees and other pollinators in uniform agricultural landscapes with floral resources. Their effectiveness depends on the landscape context, but two issues important for landscape analysis have remained unstudied: what are (i) the most critical geodata (content and spatial resolution) and (ii) the most relevant spatial scales to represent landscape pressures for the evaluation of abundance and diversity patterns of wild bee species on perennial wildflower strips? The aim was to analyse effects of land cover and agricultural practices on wild bee species diversity and abundance on perennial wildflower strips at spatial scales from 200 m to 10 km.
Using a dataset of wild bees on perennial wildflower strips across the agricultural landscape of Saxony-Anhalt we investigated landscape effects on the numbers of wild bee species and individuals, and the share of Red List bee species. Influencing factors included land cover / land use, protected areas, crop types, agri-environment schemes, intensity of agriculture, and intensity of grassland farming. Data on land cover / land use were compared between a federal state biotope type mapping, the Basic Digital Landscape Model (DLM), and high-resolution land cover maps from the Copernicus Programme.
The results revealed that numbers of wild bee species and individuals benefit from bare soil and ecological focus areas up to 3 km distance, whereas the share of Red List species was positively influenced by various factors especially at large scales up to 10 km, e.g. wood structures and grassland. The main land-use classes were largely consistent across data sources, suggesting a high potential of data from the DLM together with the Integrated Administration and Control System (IACS/InVeKoS) to indicate effects of landscape structures and agricultural practices on the species composition and distribution of wild bee assemblages in Germany.

09-O-09 - Effects of historical landscape structure on current community trait composition of plants and arthropods in Central European grasslands

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The effects of current landscape structure on ecological communities are well observed and understood but studies often ignore the importance of historical landscape configuration and composition, which may significantly influence composition of ecological communities beside present land-use management.
In this study, we investigate the effect of several landscape metrics calculated for four different time periods in the last 200 years on trait composition of plant and arthropod species. These landscape metrics were calculated for 150 grassland plots and their surroundings. The plots are situated in three regions of Germany as part of the Biodiversity Exploratory project. We conducted a combined RLQ and fourth-corner analysis to find the most influential landscape variables and the most responsive traits.
We hypothesize that historical local land use and habitat configuration explain a significant amount of extant trait composition of communities, and that dispersal-limited species are more numerous in focal patches with better connectivity to surrounding grasslands. We further hypothesize that the proportion of short-lived species and species with specialized regeneration modes will increase with increasing grassland patch area.
Preliminary results show that plant specialist species of dry grasslands are negatively affected by current land use intensity and positively by the edge density of grasslands within a 1000 m radius around the focal plots. Further results concerning the strength of historical compared to current variables, the influence of newly created habitats versus fragmented habitats and their effects on community (weighted) mean traits will be available and presented in August.
With this study we hope to address the knowledge gap of how historical habitat configuration affects community assembly and to shed light on the importance of historical landscape structures compared to extant environmental conditions.

09-P-01 - Distribution ranges and recruitment of tree species in European natural forest ecosystems

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Tree species distributions in European temperate forest ecosystems are limited by either abiotic stress or biotic factors. Complex feedbacks between climate, soil and biotic factors define forest succession and, in the long-term, the distribution limits of tree species. Understanding these processes at regional scales is important to project forest development under climate change and guide forest management to warrant the provisioning of ecosystem services. However, little is known about natural forest succession on larger scales because studies focus on small-scale experiments, whereas large-scale data from undisturbed forests are missing. Experimental studies cannot fill this gap since they are challenged to capture the complexity of natural forests along multiple environmental gradients, whereas studies on managed forests are only of limited use for inferring natural processes. Thus, large-scale studies on undisturbed forests are necessary to understand the distribution limits of European tree species and their implications under climate change. We present a study of tree species distribution ranges with a focus on tree recruitment from natural forests covering 17 European countries and 18 research groups. We derive estimates of the abundance of tree recruitment, relative growth rates and survival probability of small vs. large trees from a unique set of 5722 unmanaged forest plots which have been resurveyed one to six times between the years 1936 and 2020. We compare these empirical estimates with results of a dynamic forest gap model to show how different processes shape tree recruitment patterns along environmental gradients (degree-day sum, water balance and soil conditions) throughout Europe. This presentation will highlight preliminary results of this ongoing study.

09-P-02 - Small-scale tree species effects on arthropods in different forest stand types – a case study of carabid beetles

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Central European forests are primarily managed on the basis of small-scale silvicultural activities that influence the spatial distribution of trees. It is believed that the admixture of additional tree species leads to spatial patterns characterized by specific, small-scale environmental conditions, thereby creating niches for arthropods. The study combines the spatial, distance-dependent effect zones produced by individual sessile oak and Scots pine trees with the superordinate level of typical forest stand types. Three spatial effect zones characterizing environmental conditions associated with pure oak, mixed oak–pine and pure pine were defined. The activity density of five large carabid species, assessed by their sex, were recorded with pitfall traps arranged in 15 m x 15 m grids on sixteen study areas. These study areas represent the following oak and pine tree constellations typical in the German lowlands: (i) pure oak, (ii) equal mixture of oak and pine, (iii) pine with less than 10 % oak and (iv) pure pine. The cartesian coordinates of all trees were mapped. Generalized linear geostatistical models (GLGM) and generalized linear mixed models (GLMM) were used for the spatial analysis of the tree species-dependent activity densities of carabids. At both spatial scales – effect zone and stand level – the carabids showed significant species- and sex-specific differences in their activity densities. *Carabus coriaceus*, *C. hortensis* and *Calosoma inquisitor* were completely absent in the pure pine stands. *C. coriaceus* and *C. hortensis* reached the highest activity densities in pine stands with oak proportions of less than 10 %. At the smaller spatial scale of tree effect zones imagines and males of *C. violaceus* were positively related to pine zones whereas females had an affinity for the oak zones. The activity densities of both *C. arvensis* sexes were similar in all three zones. Females and males of *C. coriaceus* and *C. hortensis* revealed affinities for oak zones.

09-P-03 - *spectre*: An R package to estimate spatially explicit community compositions

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Understanding how biodiversity is spread across space is key to many aspects of ecology and conservation. Many predictive modelling approaches have been developed to estimate the distribution of biodiversity over various spatial scales. Community modelling techniques may offer many benefits over single species modelling, but most of these techniques can only predict one aspect of biodiversity (either α- or β-diversity). Here, we present an R package, *spectre*, that can predict species-specific community compositions across spatial scales, using only sparse biological and environmental data. Underlying the *spectre* package is an optimisation algorithm that calculates species' presences and absences throughout a region using estimates of α-, β- and γ-diversity. *spectre* is an easy to use and accessible tool facilitating further research and knowledge acquisition into spatial community ecology.

SESSION 10

Impacts of Recent Climate Extremes on Plant Functioning in Terrestrial Ecosystems

CHAIRS: ***Nadine Ruehr, Henrik Hartmann, Miguel Mahecha, Jürgen Kreyling***

The climate of the 21st century shows a consistent trend of increasing temperatures and changing precipitation patterns. Since the turn of the century most years were warmer than what would be expected from the long-term average. In particular, the years 2018 and 2019 were marked by extreme, record-breaking summer temperatures in central Europe and 2018 was also one of the driest years of the past 140 years. In some parts of Germany, Austria and Switzerland agricultural yield was substantially reduced and many forest tree species showed symptoms of decline or died in response to heat and drought, either directly or due to reduced resistance against pests and diseases. Forest and agricultural damage have been reported so far in terms of loss of timber volume or harvest grain mass, but these assessments do not account for the ecological impact of increased mortality or reduced productivity in grasslands, marshes and forest ecosystems. This session seeks to provide a platform for studies on impacts of extreme climate events on all aspects of ecosystem services in terrestrial ecosystems including forests, grasslands, mires and heathlands. Examples include assessments of spatial patterns or extent of decline or mortality, loss of productivity as well as impacts on greenhouse gas fluxes, or changes in species composition and the underlying processes. We welcome studies using a variety of different approaches including remote sensing, inventory assessments or field investigations. In addition, the session welcomes contributions from vegetation modeling allowing forecasting of ecosystem condition under anticipated future climate scenarios.

10-O-01 - Recent and future forest mortality in Germany - what will come after the spruce age?

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In the future German forests are likely to suffer more under extreme weather events like heat waves and drought accompanied by biotic threats, as experienced in the years 2018 to 2020. This is in particular true for drought sensitive Norway spruce stands. Thus, the risks maintaining to use the most common commercial tree species, spruce, will increase. While the recent forest damages amount to 277,000 hectares to be reforested, the projected risk area for stand mortality may strongly increase to 2.2 million hectares until 2050, for spruce only. However, also European beech may be at risk with up to 0.6 million projected risk area until the mid of the century. Forest adaptation to future increased extreme events and accompanying biotic risks requires forest transformation on nearly 100,000 hectares per year, the fourfold area rate than today. This can induce total costs between 14 and 43 billion Euros within the next 20 years. This talk will present risks and option of climate change dynamics and adaptive measures from the perspective of forest dynamics, forest management and forest resource use, and will draw conclusions for best practice approaches of adaptive forest management in order to keep the integrity of future forest ecosystems.

10-O-02 - Beyond the borders of tree physiological function: tree responses to the exceptional 2018 summer drought

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In 2018, an exceptionally severe summer drought impacted European forests, causing wide-spread canopy dieback and tree mortality. On the recently established Swiss Canopy Crane II site, we explored in mature individuals of Norway Spruce and European Beech the effect of this exceptional drought event on tree physiological integrity. Specifically, we aimed to investigate water and carbon relations in trees at the edge to drought-induced mortality. All trees developed very low branch water potentials, coming close to, or even exceeding, the critical xylem pressure leading to a loss of xylem hydraulic conductance and hydraulic failure. The drought impact on the tree hydraulic system was associated with stomatal closure and depletion of non-structural carbohydrates (sugars and starch). Those Spruce trees which died during the 2018 summer drought showed a sudden decline of branch water potentials to exceptionally low values and a complete loss of xylem hydraulic conductance, suggesting rapid hydraulic collapse and dehydration as the main cause of drought-induced mortality. Beech trees survived the 2018 summer drought, but developed striking symptoms of canopy dieback in the following spring and summer. These post-drought damages were associated with a persistent loss of xylem hydraulic conductance. Taken together, our observations clearly show that Spruce and Beech trees came close to, or even exceeded, the tipping points of tree hydrological integrity. The sudden collapse of the hydraulic system in Spruce during drought and the occurrence of heavy post-drought canopy damages in Beech strongly support high vulnerability of these species to severe drought.

10-O-03 - Early leaf fall of European beech during the 2018 summer drought: sign of impairment or strategy of stress avoidance?

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The severe summer drought of 2018 has strongly affected Central European forest ecosystems. In various parts of Switzerland, the hot drought induced premature leaf senescence and early leaf fall in beech. It is largely unknown whether this phenomenon is a mechanism of stress avoidance protecting trees from more severe damage or a consequence of hydraulic failure indicating the drought sensitivity of beech. In particular, the development of crown mortality over time may be exacerbated by drought legacy effects such as insect or fungal pathogen attacks. In this quantitative survey, we followed the development of crown mortality and re-growth of new shoots as well as secondary drought impacts such as insect or fungal pathogen attacks of 964 beech trees in three regions in Northern Switzerland for three consecutive years. We found that trees with premature leaf fall in 2018 showed increased crown mortality and were more vulnerable to insect and fungal pathogen attacks in 2019. In 2020, the increase of crown mortality of highly damaged trees continued but was less pronounced and all trees showed fewer signs of insect and fungal pathogen attacks. We also observed re-growth of new shoots in the crown of less damaged trees. Increasing crown mortality in the years following the 2018 hot drought suggests that the observed early leaf fall in beech was a sign of irreversible hydraulic failure for the majority of examined beech individuals rather than a strategy of stress avoidance. The strong drought-legacy effects were effects were in two of three regions amplified by the consecutive hot drought in summer 2019. The observed vulnerability of beech to drought indicates that longer and more frequently occurring drought periods, as expected under continued climate change, will generally challenge the structure and function of beech forests, in particular on drought-prone sites.

10-O-04 - Repeated summer drought impairs the water balance of spruce stronger than of beech in intra- and interspecific competition

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Recent years have alarmingly shown that prolonged and repeated summer droughts in combination with high temperatures have devastating effects on forests not only throughout Germany but also globally. However, responses of the water balance of adult trees and forest stands to repeated drought events followed by a recovery phase are still scarce. Here, we present the impairments of repeated drought events on the water balance of mature beech (*Fagus sylvatica*) and spruce (*Picea abies*) growing in intra- and interspecific competition. In the Kranzberg roof experiment (KROOF), summer precipitation was excluded via retractable roofs in five consecutive years (2014 to 2018). This resulted in strong dehydration of the upper 70 cm of soil, reducing pre-dawn leaf water potentials to as low as -1.8 MPa. The low water availability resulted in a reduction of xylem sap flux density by up to 80 % in spruce and 40 % in beech compared to untreated control trees. Additionally, repeated summer droughts led to an adjustment of the radial profile of xylem flux density in spruce stems, further reducing their overall water consumption. Thus, beech trees appear to benefit from the reduced water consumption of drought stressed spruce during the summer months when growing in interspecific competition. Mechanisms reducing water use in spruce are first, the quick and strong reduction in stomatal conductance during drought and second, morphological acclimations (e.g. reduced leaf area or stem increment) under repeated drought. Drought stress release by watering of plots in 2019 resulted in a quick recovery of physiological parameters, such as water potential or xylem flux density, in both species. However, water use in formerly drought-stressed spruce was still significantly reduced and morphological acclimation to drought was not yet fully recovered within the first year of recovery. Beech growing in mixture benefits from the reduced water use of spruce during and after drought stress release.

10-O-05 - Drivers of long-term change in biomass in Swiss forest reserves

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Forests have the ability to mitigate climate change by carbon sequestration. Some temperate forests of different stand ages are featuring high rates of biomass increase, but this positive trend in forest growth is not universal. It may be due to the combined effects of temperature rise and associated longer growing seasons, CO_2 fertilization which may also facilitate higher water use efficiency and continued high N deposition. However, water shortage and increased VPD may also cause a growth decrease. The aim of this study is to understand how aboveground living biomass accumulates in unmanaged forests, i.e. where management does not complicate the interpretation of biomass trajectories. Long-term inventory datasets from forest reserves offer a unique opportunity in this context. We used forest inventory data from a very large network of permanent plots established in Swiss forest reserves covering a wide environmental gradient. We studied 149 plots covering 77 ha with remeasurements approximately every 10 years over the last 60 years. We modelled biomass changes over time using mixed-effect models including a comprehensive set of abiotic and biotic factors, emphasizing the impacts of changes in temperature and the water balance. Preliminary results reveal clear differences in trends between different altitudinal vegetation zones. Forests at higher elevations showed faster biomass accumulation rates, as well as total aboveground living biomass than forests at lower elevations. Nevertheless, in recent decades their growth has stagnated. Differences in site conditions such as soil fertility or slope do not explain the observed variance within altitudinal vegetation zones. A more advanced stage of the results of this ongoing study will be presented.

10-O-06 - Grasslands under stress: nitrogen loading intensifies drought impact through vegetation shifts

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Nutrient loading and drought events are two important threats to the sustainable functioning of semi-natural grasslands in temperate zones. These threats may cause substantial shifts in species richness and abundance and thereby considerably alter the carbon and water balance of grasslands. The interacting effects between those two threats, however, are complex and poorly understood. Here, we conducted a multifactorial field experiment to investigate the effects of nitrogen loading and extreme drought (separately and combined) on a semi-natural temperate grassland, located in Freiburg (South Germany). We combined eddy covariance techniques with open gas exchange chambers to assess the response of grassland water and carbon fluxes. Gas exchange chambers were connected to an infrared gas analyzer and water isotope spectrometer, which allowed the partitioning of net ecosystem exchange and evapotranspiration. Vegetation parameters were described by species richness, species abundance, and leaf area index. Our results suggest that grassland communities, strongly weakened in their stress response due to nitrogen loading, can substantially lose their function as carbon sink during drought periods. Over the growing season (April - September), the carbon sequestration of the studied grassland was reduced by more than 60 % as a result of nitrogen addition. Nitrogen addition in combination with precipitation reduction decreased carbon sequestration by 73 %. The negative impact of treatments on carbon sequestration was related to strong vegetation shifts. While nitrogen addition caused a significant loss in forb species (− 25 %), precipitation reduction promoted a strong dominance of grass species at season start. Consequently, the species-poor and grass-dominated community suffered from a strong above-ground dieback during the dry summer months, likely caused by a lower water use efficiency and weaker drought adaptations of the grassland community. Our findings demonstrate that eutrophication can severely threaten the sustainable functioning of grasslands, in particular when drought periods will increase in future due to climate change. Moreover, they emphasize the importance of preserving high diversity of grasslands to strengthen their resistance against drought events.

10-O-07 - Drivers of Net Primary Production (NPP) changes in southern Africa - satellite estimates and process-based dynamic vegetation modelling

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Net primary production (NPP) is a crucial ecosystem variable for food security. It is the basis of most life on Earth, including carbon cycle. Dynamic global vegetation models (DGVMs) have become effective tools to study and estimate NPP. Particularly in arid ecosystems, it is imperative that DGVMs are able to capture water limitation and drought effects on vegetation. However, previous studies have revealed weaknesses in this regard. In this study we used a DGVM, the Lund-Potsdam-Jena General Ecosystem Simulator (LPJ-GUESS) to simulate NPP in southern Africa over the time period 1982 - 2015. We compared various satellite-derived estimates of NPP dynamics and related proxies [Advanced Very-High-Resolution Radiometer (AVHRR) Normalised Difference Vegetation Index (NDVI), Moderate-resolution Imaging Spectroradiometer (MODIS) NDVI and NPP] with simulated NPP and precipitation. Modelled trends and interannual variability correspond well with the satellite estimates. This increases the confidence into the satellite trends and our understanding of the underlying mechanisms. Further analyses indicate that changes in precipitation are the main driving force, far more important than, e.g., CO_2 fertilization and land use. The results also suggest model's ability to be applied for future climate impact projections in southern Africa.

10-P-01 - Effects of prolonged summer drought periods on arbuscular mycorrhizal and total fungal communities in grasslands along a plant diversity gradient

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Biodiversity loss and climate change have been determined as global drivers affecting ecosystems and their functioning. In the context of global change, drought was shown to have negative effects on ecosystems by disrupting ecological processes and altering community compositions. Many studies however focussed on effects on aboveground communities while dynamics of soil-borne communities are still widely unclear, despite their important roles in ecosystem functioning. To elucidate the effect on fungal communities, prolonged summer drought periods were simulated by installing roof shelters on grassland plots within a long-term grassland biodiversity experiment. This experiment includes grassland compositions along a plant diversity gradient of 1-60 species constructed from 1-4 plant functional groups including the factor of biodiversity loss. At the end of an 8-year period, bulk soil was sampled and used for DNA extraction and Illumina sequencing of ITS2 and SSU sequences for total fungi and arbuscular mycorrhizal (AMF) communities, respectively. Results showed shifts of total fungal and AMF community structures caused by drought treatment and plant species richness, but no interaction of these factors. AMF communities were additionally affected by presence/absence of individual plant functional groups. Alpha diversity (ASV richness) of both total fungi and AMF increased with plant diversity richness, but was not affected by the drought treatment. Alpha diversity of AMF responded to presence/absence of short and tall herbs, while for total fungal communities, grasses and legumes played a more important role. Results showed also differences in total fungal taxonomic composition along the plant diversity gradient and differential abundance of few fungal species between drought and control plots. Our results indicate that effects of plant diversity on belowground communities surpass effects of summer droughts, but drought does cause shifts in community compositions.

10-P-02 - Root cortical aerenchyma, characteristics and nutrient use efficiency of different maize hybrids during drought and rehydration process

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Background and aims: The importance of cortical aerenchyma in flood and drought resistance is well established. However, the mechanisms of aerenchyma formation in maize are described only considering drought and rehydration alone, and the effects of the combination of these two factors remain unclear. We tested the hypothesis that under conditions of dramatic water alteration, enhanced root cortical aerenchymas (RCAs) could not only exert a positive effect on the root functions under drought periods but also influence nitrogen capture, soil exploration, and biomass after rehydration. Methods: Three maize varieties (YR 6, YR167, and YR2) were grown under rainfed field conditions. A subset was grown initially under well-watered and extreme-drought conditions followed by the same simulated rainfed field conditions to compare the effects on the RCAs during the growing season. The stability of different varieties, including the resistance during drought simulation and the resilience after rehydration, was estimated and root morphology and function parameters were measured, and variation in the RCAs induced by water stress. Key results: Under extreme drought, we found substantial variation in the RCAs (from 0% to 37%) and drought tolerance performance. During the rehydration stage, different RCA components exerted different effects on maize, recovery parameters, and plant N use efficiency. YR6 showed resilient growth, whereas recovery was inhibited in YR167 and YR2, respectively, which possessed the lowest and highest RCA areas. Conclusion: The results support the hypothesis that RCA components under drought periods are important for maize recovery after post-drought rehydration.

SESSION 11

Scales and Patterns of Soil Microbial Diversity

CHAIRS: ***Christoph Tebbe, Michael Bonkowski***

Since the advent of high-throughput DNA sequencing technology it has become feasible to capture the almost total diversity of microorganisms (bacteria, archaea, fungi and protists) in a soil sample. While DNA sequencing data are now accumulating, our capacity to predict the alpha diversity in soils and microbial community responses to treatments (beta-diversity) or environmental changes is still very limited. A major reason for this limitation is seen in the diversity of spatial scales which is applied to monitor microbial alpha- and beta-diversity. The objective of this session is therefore to present studies on soil microbial diversity which consider scales from soil aggregates to landscapes or even bio-geographical regions, and thereby stimulate the discussion about spatial scale selections and the best methods to analyze soil microbial communities appropriately.

11-O-01 - Microbial necromass in soil organic matter - implications for soil microbial ecology

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Microorganisms are known to be essential for soil organic matter (SOM) formation as catalysts, but their matter contribution was rarely analysed. They transform plant litter as a carbon and energy source for biomass formation. After cell death, necromass may enter microbial feeding cycles or is stabilised in SOM. A meta-analysis of data on microbial biomarkers, e.g. amino sugars (AS) and phospholipid fatty acids, showed microbial necromass in SOM ranging on average from 62 % at grassland sites to 56 % at arable land and 33 % at forest sites (Liang et al, GCB, 2019). This shows a significantly higher contribution to SOM than previously considered and has important implications for understanding SOM stabilisation and soil functions reviewed here. Well-known mechanisms are organo-mineral interactions altering mineral surfaces. The chemical structure of microbial necromass provides features for additional stabilisation by aggregations of biomolecules and incrustation by metals or carbonates. Proteins show a high meta-persistency in soils due to post-mortem aggregation and conformational changes. Carbon retention in soils depends on substrate availability, energy flux, maximum growth and carbon use efficiency of the organisms and environmental boundary conditions. Soil microorganisms presumably optimize their energy fluxes and thus recycle biomass building blocks avoiding energy expenditure for biomass synthesis.

11-O-02 - Importance of soil primary particles for shaping the diversity and activity of soil microbial communities - Results of a meta-analysis

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Soil primary particles, i.e. sand, silt, and clay are the building blocks of soil differing in specific surface area, mineralogy, quantity and quality of associated soil organic matter, and surface reactivity. By means of physical disruption of soil aggregates, e.g. by sonication, primary particle size fractions (PSFs) can be separated and analysed, and our own studies demonstrated the usefulness of this approach to characterise particle-associated microbial communities. However, fractionation procedures are not standardised in terms of sonication conditions and classification and set of separated PSFs. Considering these obstacles, a meta-analysis of studies applying this approach to characterise microbial abundances, community compositions, and activities was conducted. General microbial and specific prokaryotic markers indicated a clear increase of microbial abundances from coarser towards finer PSFs. However, sand-sized PSFs containing co-collected particulate organic matter could harbour higher abundances than the next finer PSF. The ratio of fungi to prokaryotes decreased towards finer PSFs, while the ratio of archaea to bacteria increased. Proteobacteria were more dominant in coarser PSFs, while Actinobacteria and Firmicutes were more prevalent in finer ones. In comparison to other factors, the importance of primary particles for structuring communities decreased from bacteria over fungi to archaea. Among microbial activities dehydrogenase activity, respiration, and nitrogen mineralisation followed the patterns of abundance. In contrast, metabolic quotient and carbon mineralisation showed no such pattern, but were probably the result of individual soils' characters and measuring conditions. Overall, this meta-analysis confirmed the importance of soil primary particles for orchestrating soil microbial diversity and activity. Future research would greatly benefit from utilising standardised methods to separate PSFs and their associated biological components.

11-O-03 - Soil prokaryote richness follows classic Species-Area relationships across scales with consequences for large-scale composite sampling.

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Soil prokaryote communities can be considered across scales from single aggregates (circa. 2 mg) to conventional DNA extracts (500 mg) or even homogenized, composite samples (≥ 1 kg). The scale at which a community is analyzed may not correspond to that of a process or geochemical properties of interest, which is often the purpose for investigating microbial alpha-diversity, e.g. questions such as what optimal pH fosters biodiversity. We first sought to model the relationship between prokaryote Richness and scale as soil weight. Richness, as unique amplicon sequence variants (ASVs) per sample, across 1, 5, 25, 125 and 250 mg was curvilinear, with Richness increasing with scale. Cross-validation of three models, on equally sized training and testing datasets, confirmed the best means to describe soil microbial richness is as a classic power law Species-Area Curve, where the primary unit of scale are aggregates of circa. 1 mg. It was predicted that in top-soil (0 - 10 cm) of a 1 m^2 area where bulk density ranges from 1.1 - 1.6 g/cm^3 and geochemical properties (e.g. carbon, pH) are homogenous and consistent with our sampled soil, there are 7308 - 7344 ASVs. Secondly, we sought to develop insight into how richness is affected by pooling composites from soils of different properties which is a frequently used sampling technique in soil science and microbial ecology. With soil from the La Cage long-term field experiment (Versailles, France) where subplots within a single field (1 ha) vary by nitrogen addition (high, low) and crop (wheat, rapeseed), the richness of individual subplots versus pooled subplots was compared. In both cases, pooling significantly increased richness by 1.5 - 2 x greater than predicted by the Species-Area model, indicating over-estimation of alpha-diversity. In microbial ecology studies where relationships between alpha-diversity and a process or property are sought, we suggest measuring both at the smallest possible but congruent scale.

11-O-04 - Assembly patterns of the rhizosphere microbiome along the longitudinal root axis of maize (*Zea mays* L.)

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Different plant species select for individual subsets of bulk soil microbial communities within root systems – the rhizosphere microbiome. Roots however constitute quite dynamic environments. Changes in root elongation rate combined with changes in the quality and quantity of rhizodeposition between different root regions lead to continuously changing conditions for root-colonizing microorganisms. As the microbiome concept implies a rather static outcome of the microbial assembly, it raises the question as to where and how the dynamic transition of a microbial bulk soil community into a plant species-specific rhizosphere microbiome is taking place.
We investigated the community assembly of prokaryotes and their microbial predators (Cercozoa, Rhizaria, Protists) along the longitudinal root axis of maize (*Zea mays* L.) in a laboratory experiment. Rhizosphere soil was sampled at distinct locations along roots to track the diversity and co-occurrence of rhizosphere microbiota by high-throughput sequencing.
High variation in beta diversity at root tips and the root hair zone indicated initial randomness of community assembly and lack of resource limitation according to co-occurrence networks. Resource limitation in regions where lateral roots emerged led to more deterministic community assembly, likely driven by competition and predation. In regions with fully developed lateral roots the appearance of regular phylogenetic co-occurrence patterns in bipartite networks between prokaryotes and their microbial predators, suggested strong top-down control and that a consistent rhizosphere microbiome finally assembled. For the targeted improvement of microbiome function, such knowledge on the processes of microbiome assembly on roots and its temporal and spatial variability is of crucial importance.

11-O-05 - Investigating microbial diversity across an urbanity gradient in Berlin

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The soil within urban landscapes provides vital ecosystem services, many of which are directly related to the microbial communities within them. The taxonomic groups making up these communities are still not defined and the influence of urbanity upon their diversity is poorly understood. In this study we aimed to rectify this by analysing the diversity of four different microbial groups in grasslands across an urbanity gradient in Berlin. Using high throughput illumina sequencing we explored bacterial, cercozoan and fungal diversity, with a separate dataset for glomeromycetes. By using principal component analysis, we collapsed 45 different environmental variables into three axes of environmental variation relating to ‘urbanity’, ‘soil nutrients’, and ‘heavy metals and pH’. Our results showed that fungal and bacterial diversity increased with urbanity and exhibited a nested community structure. When we examined the data at a higher taxonomic resolution, our results demonstrated that for many microbial phyla, including the Ascomycota, Basidiomycota, Actinobacteriota and Proteobacteria, urbanity was the most important explanatory variable of diversity across the urban landscape.

11-O-06 - Measures of phylogenetic diversity illuminate structuring of mushroom assemblages across Europe

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Increasing average temperatures and changing temperature seasonality across macroclimatic scales due to global warming re-organize species communities. Macroecological studies increasingly focus on the mechanistic link between the occurrence of species and the thermal environment to increase predictability. Compared to other kingdoms fungi only recently gained attention in macroecology. It has been demonstrated that fungal communities are correlated to the thermal environment. However, the underlying processes how fungal species assemble on large scales remain unexplored. Here we use a mega-phylogeny and 2,822 species distributions across Europe and ask whether fungal communities are phylogenetically structured along thermal gradients. To shed light on historical evolutionary and contemporary ecological mechanisms we used phylogenetic diversity measures at alpha and beta level. We found a significant and hump-shaped response of phylogenetic alpha diversity with mean temperature and a significant positive linear relationship with temperature seasonality. Further, phylogenetic beta diversity was significantly correlated with more dissimilar mean temperature and seasonality on deep and shallow phylogenetic levels respectively, a response mainly driven by exclusive genera in thermal extremes. These results suggest that fungi are structured by the thermal environment and at least partly by specialization towards thermal extremes in mean and variation. Climate change might thus lead to selection of high-temperature and expulsion of low-temperature adapted species with unknown consequences for ecosystem processes.

11-P-01 - Fine-scale temporal monitoring of soil microbial communities at an agricultural field site

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Soil microorganisms play vital roles in agricultural ecosystems including nutrient cycling, soil fertility maintenance, and plant health protection. Their ecosystem services are increasingly appreciated in context of developing sustainable agricultural production systems, and consequently it is proposed to consider them for large-scale, long-term monitoring programs. To propose the best sampling strategies, it is important to understand the impact of seasonal variation along with soil structure and management practices on microbial community abundance and diversity. Therefore, we selected for this study three neighboring agricultural fields which differed in soil texture (clay vs. loam) and tillage practice (conventional vs. conservative) and collected representative soil samples every two weeks, starting in March 2020. In this ongoing study, we analyze directly extracted soil DNA for microbial communities by qPCR and PCR amplicon sequencing and distinguish between bacteria, archaea, fungi and protists (*Cercozoa*). Our qPCR results indicated based on gene copy numbers per g of soil that bacterial abundance was not significantly affected by soil texture or tillage practice. For the seasonal impact, a minor but significant increase was detected during spring. In contrast, archaeal abundance differed between sites, indicating that both soil texture and soil tillage had an impact. Their abundance was higher in autumn and winter. The same result was seen with fungi. Furthermore, fungal abundance was higher in the clay soil and with conservative tillage. Currently, we analyse the diversity of the microbial communities by PCR amplicon sequencing. Overall, our preliminary data suggest that seasonal changes must be considered when collecting and comparing microbiological data for larger-scale long-term monitoring studies.

SESSION 12

Dynamic Ecosystems in a Changing World

CHAIRS: ***Sabine Fink, Kristin Ludewig, Tillmann Buttschardt, Harald Grote***

The fate of dynamic ecosystems such as e.g. fire-prone habitat, storm water ponds, floodplains, coastal ecosystems remains unclear, since they are endangered due to human pressure and changing climate. Many global and national guidelines designate dynamic ecosystems as conservation priorities, but specific management methods are required to allow for human use (e.g. recreation) but still ensuring conservation of habitats as well as rare and adapted species in dynamic zones. Common strategies for conservation management are frequently not applicable to dynamic ecosystems due to the stochastic nature of dynamic events. The lack of reference systems for natural processes in dynamic zones with or without human impact further creates scientific challenges - bonds can be obtained from the use and management of military areas, as dynamic living spaces have been preserved here for decades. This session aims at contributing management strategies for dynamic ecosystems based on scientific studies, and practical experience such as the use and management of military sites. While we focus on the transition of results from scientific studies to practical conservation work and are interested in the role of stakeholders in nature conservation (e.g. military, farmers), we also welcome contributions investigating functioning of dynamic ecosystems per se.

12-O-01 - Dynamics of salt marsh plant communities in response to environmental conditions and habitat fragmentation

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Environmental change exposes salt marshes to increasing frequency of inundation, salt-water intrusion, soil waterlogging and mechanical erosion by waves. Despite the adaptive nature of salt marsh vegetation, these new conditions may modify the survival, growth, reproduction and competitive ability of salt marsh plant species and change the plant distribution. To address the community dynamics and assembly of salt marshes under limited dispersal conditions, we installed 12 experimental islands on a tidal flat in the German Wadden Sea. Each experimental island consisted of three elevational levels corresponding to the vegetation zones in the adjacent salt marsh. Six islands were planted with sods from the lower salt marsh, and six islands were left to display bare sediment. Transplanting communities to different elevations allowed to identify the response time of plant communities to changed environmental conditions and compare it to spontaneous colonisation on bare patches. Experimental plots at the same elevations were established in the adjacent salt marsh on the island of Spiekeroog. We studied how the succession of salt marsh communities due to drowning or emergence interacts with processes at the metacommunity scale. We used all relevant plant traits to analyse the similarity of species and relate trait modules to the behavior patterns of plants on the salt marshes. Environmental stress controlled the abundance of salt marsh species in the pioneer zone and change towards more stressful environment caused quick initial response. Competition on the other hand took several years to impact community composition. Using an experimental meta-community approach in combination with functional trait framework, we show that strong environmental gradients are dominating the community development in the salt marshes, but the deterministic processes are strongly affected by fragmentation and stochastic disturbances.

12-O-02 - SeaStore: Diversity enhancement through seagrass restoration

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Seagrass meadows promote biodiversity and provide important ecosystem services (ESS) for coastal protection and climate change mitigation. In Germany, seagrass declines stopped. However, natural recolonization of meadows is slow due to limitations in dispersal and establishment. SeaStore will advance active marine habitat restoration and provide the scientific basis for a robust and scientifically sound re-establishment of seagrass in Southern Baltic waters. Based on the identification of dominant factors within the ecological niche, a restoration facilitator will be developed to support plant establishment and growth. Also, a comprehensive evaluation of the effects of natural and restored seagrass meadows will be assessed, including ESS, ecological and economical values. We will compare the cost of habitat loss with investments in the restoration of the same ecological functions and ESS. At the same time, we will promote the acceptance of seagrass meadows to increase the willingness to invest in the restoration of these habitats. By coupling seagrass biodiversity and ESS in models, this project contributes to the German and EU strategy for nature protection. The results will support decision makers in planning seagrass restoration and provide information material for coastal communities wishing to raise awareness for seagrass meadows and their ESS in coastal protection and adaptation to climate change.

As the SeaStore field experiments are ongoing, we present some results from Sweden, showing how seagrass functional traits (FT) fluctuate in the last 25 years in relation to environmental changes. We used the SHARKweb dataset, which contain multiple information on *Zostera marina* FT to extract relevant environmental variables from the datasets available on Google Earth Engine. This approach allows the incorporation of large biodiversity datasets with environmental variables to produce robust explicit spatiotemporal forecasts of changes in species FT.

12-O-03 - Colonisation and gene flow in a highly dynamic habitat: Case of *Myricaria germanica* fourteen years after river restoration

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Alpine rivers are highly dynamic ecosystems and belong to the most threatened ones in Europe. Particularly pioneering riparian species are endangered due to habitat loss through altered river dynamics. There are several revitalisation projects trying to restore riparian habitats and their natural dynamics. The success for endangered character species, such as *Myricaria germanica,* remain uncertain, as colonisation of new riparian habitats in the dynamic riverine zone is rarely predictable and metapopulation dynamics of these species are almost unknown. Using genetic information allows assessing connectivity between populations and also tracing to source populations.
In this study, we investigate the spatial and genetic variation of a newly established metapopulation of *Myricaria germanica* along the river Flaz in Switzerland. The 3.4 km long river stretch has been newly created in 2003 - 2004 to ensure flood protection, and it provides a unique study site for the monitoring of ecological restoration success.
We found a single founder event following a larger flood event to be responsible for initial colonization of the new stretch. While the subpopulation along the stable shoreline consists of old individuals without rejuvenation, the subpopulation on the gravel bars within the dynamic zones shows a high proportion of young plants and therefore ongoing gene flow. Still, differentiation between older shrubs along the shore and younger plants on the bands was detected. This diversity might originate from pollination by populations further up- or downstream. The source is most likely located upstream the new site, consisting of several founder individuals. Intact river dynamics, i.e. connectivity and repeated larger flood events are requirements for metapopulation dynamics and successful colonization of restored riparian habitat.

12-O-04 - Habitat model for riparian plant establishment in dynamic riverine zones

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The persistence of sessile riparian plant species and their habitats along riverways is highly dependent on river dynamics. Our study focuses on the most vulnerable stage in a pioneer plant species' life, seedling establishment. We assess the most important factors for local growth by linking two modeling approaches having two different spatial scales using a hierarchical process: First, we use large-scale climatic data downscaled for Switzerland and link it to small-scale morphological information derived from high resolution topographic surveys. Derived from a two-dimensional hydrodynamic model, inundation frequency maps, and areas for gravel and sand sedimentation and erosion are predicted to further refine the niche for the riparian plant seedlings. The relationship and importance of the climatic, morphological and hydrodynamic factors for seedling establishment are investigated in a statistical model.

The framework is applied to a highly dynamic floodplain at river Moesa, in Southern Switzerland. We monitored adult individuals of a characteristic species for dynamic rivers, the German Tamarisk (*Myricaria germanica*). The site was surveyed throughout the entire flowering season (May to September) and locations of seedling establishment have been recorded. The period also included two flood events which resulted in a change in river morphology, and repeated topographic surveys were performed. Our results allow gaining insights into the importance of linking ecological and hydrodynamic models for more refined predictions for local reproduction and persistence of riparian species.

12-O-05 - Dynamische Ökosysteme in der Betreuung durch Bundesforst

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Die Aufgabe der Bundesanstalt für Immobilienaufgaben (BImA) ist es u.a., forstliche Dienstleistungen einschließlich forstlicher Bewirtschaftung und naturschutzfachlicher Betreuung des Liegenschaftsvermögens des Bundes zu erbringen. Bundesforst als Sparte der BImA fungiert zusätzlich auch als Naturschutzdienstleister auf Flächen des Nationalen Naturerbes. Die Betreuungsfläche beträgt insgesamt ca. 575.000 ha. Mehr als 400.000 ha davon sind aktiv oder ehemals militärisch genutzt.
Diese Flächen beherbergen in Deutschland einzigartige dynamische Ökosysteme, die großräumig und unzerschnitten sind und nicht dem Einfluss von Pflanzenschutz- und Düngemitteln oder dem Primat land- und forstwirtschaftlicher Nutzung unterliegen. Auf aktiv militärisch genutzten Plätzen sorgt der Übungsbetrieb für Dynamik durch Störungen: Beschuss erzeugt z.B. Totholz und lichte Bereiche auch in jüngeren Waldbeständen oder löst Brände aus. Befahrung und Bodenbewegungen schaffen unterschiedliche Geländestrukturen und Sukzessionsstadien auf engem Raum. Natürliche Dynamik gibt es z.B. bei den Gewässerökosystemen, viele Fließgewässer sind unverbaut. Der breite Übergangsbereich Wald-Offenland ist im Gegensatz zur Normallandschaft kleinstrukturiert und dynamisch.
Viele der Flächen, die nicht mehr für militärische Zwecke benötigt werden, sind im Nationalen Naturerbe dauerhaft für den Naturschutz gesichert. Wälder werden hier großflächig einer natürlichen Waldentwicklung und damit der natürlichen Dynamik überlassen. Geeignete Methoden, Flächen mit hohem naturschutzfachlichen Wert offenzuhalten, lehnen sich häufig an die frühere Nutzung an. Dies sind z.B. kontrolliertes Brennen oder der Einsatz von Pflegepanzern.
Bundesförsterinnen und -förster sind mit ihrer langjährigen Kenntnis der Flächen, deren Management und dem Umgang mit natürlichen und menschengemachten dynamischen Systemen praxiserfahrene Naturschutzdienstleister auf Bundesliegenschaften und Flächen des Nationalen Naturerbes

12-O-06 - Plant biodiversity of urban stormwater ponds

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Many aquatic and semi-aquatic habitats in urban areas are of anthropogenic origin. In heavily sealed urban areas, stormwater ponds (SP) are often the last available aquatic and semi-aquatic habitats. Nevertheless, they are affected by strong and diverse human disturbances. In addition to their primary function for the retention of stormwater, SPs can also act as sediment and nutrient traps, provide habitat for plants and animals and are used by people for recreational purposes. Three types of SPs (dry, wet and transitional forms) can be differentiated. Each is characterized by specific habitat conditions favoring different groups of plants, like macrophytes, wet meadow species or even dry grassland species. This indicates the potentially high importance of SPs as habitats for plants in urban areas, where suitable habitats for aquatic and semi-aquatic plants have been largely destroyed. While knowledge on the importance of SPs for amphibians, dragonflies and other macroinvertebrates exists, little is known about the species composition and diversity of vascular plants of different types of urban SPs. In 2017, we analyzed the species composition of vascular plants in 80 randomly selected SPs in Hamburg, Germany. We recorded all plant species with their frequency and cover as well as site conditions, such as the inclination of the shoreline and the degree of shading by trees, in different parts of each SP (shoreline and bottom). SPs were further distinguished into dry SPs and wet SPs. In total, 499 vascular plant species were found in the SPs and from these, 62 species were listed as threatened species for Hamburg. Covering less than 0.03% of the area of Hamburg, 30.3% of the species of the local flora of Hamburg were found in the SPs. These results indicate that SPs play an important role in preserving plant diversity in urban areas under heavy anthropogenic pressures.

12-O-07 - Die militärische Nutzung als Grundlage der dauerhaften Erhaltung von dynamischen Lebensräumen und Pionierarten – Zufall oder Ergebnis einer gezielten Bewirtschaftung?

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Im 1. Teil des Vortrages erfolgt eine Beschreibung des Standortübungsplatzes (StOÜbPl) Schavener Heide. Die Bundeswehr hat den Platz im Jahr 1976 von den Gaststreitkräften übernommen. Die maßgeblichen Störungen im Sinne des Konzeptes der Störungsökologie erfolgten im Rahmen der Nutzung v.g. StOÜbPl durch die Gaststreitkräfte von 1952 bis 1976 sowie durch die Umgestaltung der Liegenschaft für die Zwecke der Bundeswehr ab 1976.Militärisch wurde der StOÜbPl von den Gaststreitkräften vorwiegend zur Fahr- und Schießausbildung genutzt. Aus der Befahrung mit Kettenfahrzeugen resultierten z.T. stark gestörte vegetationsfreie Teilflächen und Erosionsrinnen. Bei der Umgestaltung des StOÜbPl durch die Bundeswehr wurde 1. die Infrastruktur wie das Wegesystem und die Entwässerung erstellt, 2. die mehrere Meter tiefen Erosionsrinnen mit Boden verfüllt. Nach der Umgestaltung wurden z.T. die offenen Teilflächen der Suksession überlassen. Von diesem Initial ausgehend haben sich vor allem im Bereich der ehemaligen Panzerfahrspuren Offenlandbiotope eingestellt. In den folgenden Jahrzehnten sich von den angrenzenden Waldrändern ausgehend eine Heide ein. Hieraus entstand das größte Vorkommen von Heide in der Voreifel mit rd. 27 ha. Im 2**.** Teil wird der StOÜbPl anhand der Übungsplatzkarte dargestellt. Dabei geht es insbesondere um die Art der militärischen Nutzung und um das daraus resultierende Landschaftsbild. Im 3. Teil wird beispielhaft die militärische Nutzung und Pflege dargestellt. Bei einem Übungsvorhaben erfolgt durch die Geländebetreuung eine Beratung des militärischen Nutzers unter Berücksichtigung der naturschutzfachlichen und -rechtlichen Vorgaben. Für militärische Liegenschaften mit Betroffenheit von FFH-Gebieten ist ein flächenscharfer und verbindlicher „Pflegeplan“ der sogenannte MPE-Plan erstellt worden, der den Anforderungen der FFH- und V-RL gerecht wird und diese mit den Interessen der militärischen Nutzung in Einklang bringt. Vorgenanntes wird bespielhaft dargestellt.

12-P-01 - Development of salt marsh margins due to the impact of abiotic environmental influences and pioneer plant traits

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The graduate school "Gute Küste Niedersachsen" of the universities in Oldenburg, Hanover, and Braunschweig investigates the environmental properties accounting for sustainable and secure coastal conditions with focus on the symbiosis of human activities, nature conservation, and ecosystem-based coastal protection. The project goal is the gain of knowledge about natural systems at different locations at the German North Sea coast to involve their ecosystem services into standardized coastal protection guidelines.
Even though salt marshes provide important ecosystem services for the coastal protection, such as wave attenuation and shoreline stabilization, a global loss of salt marshes was recorded in the last decades, which can be attributed to various anthropogenic threats and climatic change. The seaward marsh boundary is usually vegetated by halophytic pioneer species. Being strongly exposed to wind-wave climates, it plays an important role for their persistence. Especially, wave-induced lateral erosion force tidal marsh boundaries to retreat and should be considered in more detail to protect salt marsh ecosystems on one hand, and to integrate them in an ecosystem-strengthening coastal protection on the other. To understand the underlying processes of plant-environment interactions resulting in the edge formation in salt marshes, our research focuses on both, a structural analysis of vegetated edges with remote-sensing techniques and a periodic monitoring of vegetation traits at different sites including the pioneer zone in sheltered areas of a back-barrier island, Lower Saxony, and at exposed sites with groynes.

SESSION 13

Free Session

CHAIR: ***Jan Thiele***

13-O-02 - Succession comprises a sequence of threshold-induced community assembly processes towards multidiversity

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Research on ecological successions and community assembly shaped our understanding of community establishment, co-existence, and diversity. Although both lines of research address the same processes such as dispersal, species sorting, and biotic interactions, they lack unifying concepts. However, recent theoretical advances proposed to integrate both research lines and thus provided hypotheses on how communities assemble over time and form complex ecological systems. This framework predicts a sequence of stochastic and niche-based processes along successional gradients. Shifts in these assembly processes are assumed to occur abruptly once abiotic and biotic factors dominate over dispersal as main driver of community assembly. Considering the multidiversity composed of five organismal groups including plants, animals, and microbes, we empirically show that stochastic dispersal-dominated community assembly is replaced by environmental filters and biotic interactions after around 60 years of succession in a glacier forefield. Our results support recent theories and provide new insights into the emergence of multidiverse and complex ecosystems. Our study will stimulate updates of concepts of community assembly considering multiple taxa with unique and complementary ecological roles and help to bridge the gap between research on successions and community assembly.

13-O-03 - Host age at time of attachment affects the performance of the root hemiparasitic plant *Rhinanthus alectorolophus*

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Root hemiparasitic plants are generalist parasites which have green leaves but attack the roots of other plants and extract water and solutes. Some hemiparasites are noxious weeds in crops while others are ecosystem engineers which can promote biodiversity in grassland communities. Hemiparasites can attack a wide number of host species, but their performance varies greatly depending on the host species. Host size and age could also be important determinants of host quality, as they influence the amount of resources that might be extracted and the strength of competition for light between hemiparasite and host. We grew the hemiparasite *Rhinanthus alectorolophus* in a factorial design in pots with five host species, each of six different ages. Host species were planted before, at the same time or after the parasite. In half of the pots competition for light between hemiparasites and hosts was possible, in the other half not. There was a quadratic relationship between parasite performance and host age. *R. alectorolophus* grew better with hosts planted at the same time or slightly earlier, while growth was poorer with older hosts and hosts that were planted later than the parasite. Host size at the time of parasite planting, but not competition for light strongly negatively affected parasite growth. Conversely, host suppression was greater for hosts planted at the same time or shortly before the parasite. Our results indicate that the interactions between hemiparasitic plants and their hosts depend not only on host species identity but also on characteristics like host size, biomass allocation or other traits associated with developmental stage. Moreover, root hemiparasites appear to have a sensitive phase early in their development during which they can attach to a host; later this appears to be no longer possible.

13-O-04 - Indications of allochthonous marine resource use in salt marsh mesofauna of the Wadden Sea – a stable isotope (^{15}N, ^{13}C) study

Maria Rinke[1], Mark Maraun[1], Stefan Scheu[1]

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Salt marshes occur along the interface of marine and terrestrial ecosystems. In these regions distinct biomes are formed: The first zone, below the mean high-water line, is the pioneer zone (PZ), which is inundated twice a day. Above which lies the lower salt marsh (LSM), inundated only during neap tides. At >35 cm above the mean high-water line lies the upper salt marsh (USM); this zone is only inundated during storm tides. These zones are inhabited by distinct mesofauna species, essential for the breakdown and cycling of nutrients. Enrichment of marine algal material in the PZ and LSM soil have been indicated in the past, but their transfer into soil decomposer animals has not been investigated. Our study aimed to investigate the trophic structure and the use of allochthonous resources of the terrestrial soil fauna across the three salt marsh zones (USM, LSM, PZ) and also seasonality (spring, summer, autumn). We investigated the $^{15}N/^{14}N$ and $^{13}C/^{12}C$ isotope ratios of soil mesofauna and their potential resources in spring (April), summer (July) and autumn (October). Due to distinct ^{13}C enrichment of algae versus C3 and C4 vascular plants, allochthonous resources can be distinguished. Variation in the number of trophic levels occurred across seasonality, generally the USM had four trophic levels, the LSM three (four in July) and the PZ up to three trophic levels. Within the fauna $\delta^{15}N$ values varied significantly across both zone and season, with April 15N significantly reduced compared to July and October. In addition, ^{15}N values for LSM and PZ were significantly enriched compared to USM. $\delta^{13}C$ of the PZ fauna was significantly enriched compared to the LSM and USM, no significant variation across season was found. Bayesian mixing models also indicated increased consumption of marine material within mesofauna of the PZ, specifically *Z. quadrivertex* and Gamasida, with their LSM counterpart relying solely on terrestrial C3 plants. Enrichment by both ^{15}N and ^{13}C is subject to marine input and resultant allochthonous detrital input. Marine allochthonous resource use is restricted to species of the PZ, with equivalent species in the LSM indicating complete terrestrial C3 resource use.

13-O-05 - Elephant and mammalian herbivores communities' structure in Chobe District, Botswana

***Lucas Rutina*[1]**

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Elephants and rainfall have been suggested to influence guild structures of African mesoherbivore communities, leading to different responses of mesoherbivores to the abundance of elephants. I tested, at three spatial scales, the prediction that: 1) there is a clear contrast among years dominated by elephants and mesoherbivores, and years dominated by browsers and grazers 2) Mesograzers respond positively to rainfall and not affected by elephants, and mesobrowsers and mesomixers respond negatively to megaherbivores and not affected by rainfall. At any spatial scale, there were contrasts among years dominated by elephants and mesoherbivores. The contrast was reduced with decreasing spatial scale for mesobrowsers and mesomixed-feeders. Our study did not show segregation among years dominated by mesobrowsers and mesograzers and rainfall did not influence mesoherbivores biomass distribution at any scale. Mesoherbivore dietary guilds responded differently to elephant abundances and the responses were influenced by spatial scale. The mesoherbivore dietary guilds were negatively affected by elephants at a larger scale. At the broader scale, only mesograzers were negatively influenced by elephants, whereas at the finer scale only mesomixed feeders negatively influenced by elephants. This study shows that the different dietary guilds of mesoherbivores respond differently to the abundance of elephants, and spatial scales influence their responses.

13-O-06 - Land-use intensity alters networks between biodiversity, ecosystem functions and services

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Land-use intensification can increase provisioning ecosystem services, such as food and timber production, but it also drives changes in ecosystem functioning and biodiversity loss, which may ultimately compromise human wellbeing. To understand how changes in land-use intensity affect the relationships between biodiversity, ecosystem functions and services, we built networks from correlations between the species richness of 16 trophic groups, 10 ecosystem functions and 15 ecosystem services. We evaluated how the properties of these networks varied across land-use intensity gradients for 150 forests and 150 grasslands. Land-use intensity significantly affected network structure in both habitats. Changes in connectance were larger in forests, while changes in modularity and evenness were more evident in grasslands. Our results show that increasing land-use intensity leads to more homogeneous networks with less integration within modules in both habitats, driven by the belowground compartment in grasslands, while forest responses to land management were more complex. Land-use intensity strongly altered hub identity and module composition in both habitats, showing that the positive correlations of provisioning services with biodiversity and ecosystem functions found at low land-use intensity levels, decline at higher intensity levels. Our approach provides a comprehensive view of the relationships between multiple components of biodiversity, ecosystem functions and ecosystem services and how they respond to land use. This can be used to identify overall changes in the ecosystem, to derive mechanistic hypotheses, and it can be readily applied to further global change drivers.

13-O-07 - Massive conservation action leads to the recovery of amphibian populations at a regional scale

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Conservation science should provide the tools to halt and reverse population declines. While it is known that habitat creation can benefit declining populations, reports of positive conservation outcomes are few. We showcase a conservation success story from the canton of Aargau in Switzerland, where hundreds of new ponds have been built over the last decades, mainly for the benefit of amphibians. Amphibians are the most threatened vertebrate group worldwide, and habitat loss is a major driver of population declines. Fitting dynamic occupancy models for 12 amphibian species to 20 years of monitoring data, we show that persistent conservation action reverses negative population trends and leads to landscape-scale increases in metapopulation size of amphibian species. While there were regional and species-specific differences in the use of constructed ponds, all species colonized new ponds, which compensated or even overcompensated for declines in old ponds. Testing for effects of local and landscape-scale variables on colonization probability enabled us to make species-specific recommendations to improve pond creation, regarding pond (surface area, water table fluctuations) and landscape characteristics. Exploring four different measures of connectivity (distance to nearest neighbour, pond density, distance-weighted structural connectivity to all and to occupied neighbours), we found positive effects of connectivity on colonization probability for eight in twelve species. Importantly, we found that simple connectivity metrics such as Euclidian distance and pond density worked equally well as more complex, theory-derived metrics. High area of roads surrounding ponds negated or reversed positive connectivity effects in some species. We conclude that simple, but massive conservation action through pond creation can lead to population recovery of threatened amphibian species, and that easily implementable rules of thumb can help maximise conservation efficacy.

13-P-01 - Nutrient levels of an extracted raised bog nearly 40 years after restoration on black peat

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Peat extraction disturbs a bog's naturally acid and ombrotrophic character. Re-establishing near natural nutrient levels can be challenging depending on substrate quality, water table, peat layer thickness etc. Our aim was to investigate the nutrient situation in the Leegmoor, an extracted raised bog in northwest Germany. It was restored 37 years ago on residual black peat (partly <30 cm). We monitored the soil-water-chemical situation (N_t, P_t, NH_4^+, NO_3^-, PO_4^{3-} , pH) over the course of one year and compared our data to a dataset that was acquired seven to ten years after the restoration. We observed a reduction of nutrients in the surface water. NH_4^+ (Ø 0.5 mg L^{-1}) declined by about 60 %, NO_3^- (Ø 0.01 mg L^{-1}) by about 90 % and PO_4^{3-} (Ø 0.02 mg L^{-1}) by about 80 %. Soil NO_3^- decreased significantly from on average 0.6 t ha^{-1} to contents mostly below detection limit. Soil N_t (Ø 0.9 %) decreased significantly by about 10 % and P_t (Ø 0.057 t ha^{-1}) by about 20 %. Soil NH_4^+ (Ø 3.9 t ha^{-1}) and soil solution PO_4^{3-} (Ø 0.1 mg L^{-1}) did not undergo a significant change. Neither soil pH (H_20 Ø 3.4, $CaCl_2$ Ø 2.6) nor water pH (4.1) changed noticeably. Nutrient levels (except NH_4^+) were below those of other regional bogs and similar to near-natural bogs in international literature. We discussed that the nutrient situation is conflicting with the vegetation pattern of the study area. Vegetation is dominated by *Molinia caerulea*, which can thrive under nutrient enriched conditions and outcompete the bog typical vegetation. Thus, it is likely that the nutrients are not removed from the system but stored in the vegetation. In conclusion, nutrient levels of water and peat substrate stayed at a near natural state (except NH_4^+) so far. However, regarding the continued atmospheric nutrient supply and supposed finite nutrient uptake by the vegetation the nutrient status of the bog might degrade.

13-P-02 - Invertebrate herbivory on functional plant guilds may shift in the course of climate warming

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Herbivores contribute to ecosystem functioning through nutrient cycling and providing nutrients to higher trophic levels. Habitat type and landscape configuration can affect top-down control of herbivorous arthropods, while temperature affects physiology of arthropods with potential consequences on their nutritious needs. However, little is known about combined impacts of land-use and climate change on herbivory for functional plant guilds with different nutrient compositions (C:N ratio). We assessed invertebrate herbivory in three plant guilds (legumes, forbs, grasses) on herbaceous vegetation at 80–136 study sites along land-use and climate gradients in Bavaria, Germany. As possible drivers of invertebrate herbivory, we analysed landscape-scale land use (landscape diversity, edge density), local land use (aboveground biomass and habitat types: forest, grassland, arable field, settlement), and temperature (spring and multi-annual mean temperature). Invertebrate herbivory was higher on legumes than forbs and grasses, but was not significantly affected through aboveground plant biomass, local habitat type, temperature, and landscape diversity and edge density at 200–3000 m spatial scales. At higher multi-annual mean temperatures, we observed a shift of proportional herbivore damage from legumes to forbs and grasses, while the contribution of legumes to total plant cover increased with multi-annual mean temperature. Our results indicate that herbivory among plant guilds may shift in the course of climate warming with possible consequences for interspecific plant-plant interactions, plant community composition and herbivore-mediated ecosystem functions.

13-P-03 - Bioturbation along a climate gradient in Chile: Relationships between abiotic and biotic conditions and burrowing animals

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Bioturbators shape and reshape their environment with consequences for ecosystem functions. The abundance and composition of burrowing animals first of all depends on abiotic conditions with ants and mammals dominating in arid and semiarid areas and earthworms dominating in humid areas. Second, burrowing animals are tightly interlaced with biotic conditions, e.g. the activity of burrowing animals is often positively associated with the vegetation cover. It is thus essential to understand the interplay of abiotic and biotic conditions for bioturbation. In this project, we measured the density of burrows and the amount of excavated soil volume on 80 100 m² plots along a climate gradient ranging from arid to humid in Chile. We investigated to which extent the density of burrows and the amount of excavated soil volume were related to abiotic and biotic conditions, differentiating between vertebrates and invertebrates using a threshold of burrow entrance width of 2.5 cm. Our findings showed a decrease in the density of burrows from arid to humid abiotic conditions, in contrast the amount of excavated soil volume per plot remained constant. Along the gradient the density of burrows was higher for invertebrates than for vertebrates and the amount of excavated soil volume was higher for vertebrates than for invertebrates. Hence, the contribution of vertebrates and invertebrates to bioturbation changed along the abiotic gradient. While the vegetation cover showed partly positive but also negative associations with bioturbating vertebrates, bioturbating invertebrates were consistently negatively related to the vegetation cover along the abiotic gradient. These findings point to intricate relationships between abiotic and biotic conditions, bioturbators and their ecosystem functions.

13-P-04 - Spatio-temporal dynamics of the trans-Palaearctic ringlet butterfly species *Aphantopus hyperantus* (LINNAEUS, 1758)

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The genetic diversity and differentiation of most species of temperate Eurasia was strongly affected by range fluctuations triggered by the climatic fluctuations along the Pleistocene. One of these species is the ringlet butterfly *Aphantopus hyperantus* distributed over major parts of the Palaearctic region, excluding the northernmost parts of the boreal and the arctic zone, the Asian steppe belt, all regions with Mediterranean climate as well as major parts of China. The species is assumed to have retreated to refugia during the last but also previous glacial periods. In Europe, these refugia are thought to differ from the classical Mediterranean refugia, but rather correspond to the extra-Mediterranean type of survival. For East Asia, the situation is completely unclear. To reconstruct the phylogeographic history of the species, two mitochondrial (N = 206) and three nuclear (N = 200) genes were sequenced. These sequences represent two clearly separated barcode index numbers (BIN) for the mitochondrial level, less visible for the nuclear DNA. One of these BINs consisted of two clusters that showed high genetic diversity with satellite structures. The mitochondrial genes in particular showed much less genetic diversity of the other BIN. The nuclear genes exhibited similar networks, but the genetic differentiation was not as high as in the mitochondrial genes. To analyse possible interactions with the endobacterium *Wolbachia* in this context, the samples were additionally tested for this organism, but only one strain of *Wolbachia* was detected. Their distribution on the different haplotypes showed no visible pattern so that *Wolbachia* seems not to affect the genetic structures of *A. hyperantus*.

13-P-05 - A semi-field study assessing the single and combined effects of a novel insecticide and a fungicide on the solitary bee *Osmia bicornis*

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The widespread use of pesticides in agriculture is considered an important factor driving bee declines globally. Neonicotinoid insecticides have recently been banned from outside use in European crops due to observed harmful impacts on non-target organisms, such as pollinators. Alternative products, such as the sulfoximine-based insecticide sulfoxaflor, are likely to serve as replacements of neonicotinoids in the future, despite their similar mode of action. However, field or semi-field studies assessing impacts of sulfoxaflor alone and in combination with other pesticides are scarce, but urgently needed. Here, we investigated the effects of sulfoxaflor (product “Closer”) and the widely used fungicide azoxystrobin (product “Amistar”) on the survival and reproduction of the solitary bee model species *Osmia bicornis* under field-realistic conditions in a semi-field study using a full-factorial design (treatments: sulfoxaflor, azoxystrobin, sulfoxaflor + azoxystrobin, control). Forty flight cages containing *Phacelia tanacetifolia* plants (ten cages per treatment) were sprayed with the products according to label guidelines including a prior to flowering mitigation measure for the use of sulfoxaflor. The preliminary results show no major negative impacts of single or combined pesticide exposure on adult survival, number of offsprings produced or offspring survival. Moreover, neither offspring cocoon size nor sex ratio were significantly impacted by the pesticides. These findings suggest that the implemented mitigation measure for sulfoxaflor application was successful in preventing significant harmful effects on *O. bicornis*. Nevertheless, further field-realistic studies assessing potential interactive effects of exposure of pollinators to sulfoxamines and other pesticides, as well as other potential stressors, are needed to better understand risks due to potential synergistic impacts on pollinators.

13-P-06 - GFBio in NFDI4BioDiversity – A FAIR infrastructure network to support scientists in data management

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Studies focusing on ecological questions accumulate large amounts of research data. Usually, only a fraction of such data is published in conventional journal articles. Moreover, these data are often scattered throughout different repositories or not archived at all. Other data is made available via article supplements; however, this is preventing data to become FAIR: findable, accessible, interoperable and reusable [1].
The German Federation for Biological Data (GFBio [2]) supports scientists to manage and publish FAIR data in biodiversity, ecology and environmental Science. The portal (www.gfbio.org) provides a common point of access to allGFBio services: data management planning, submission, discovery, visualization and analysis, a terminology service, and a help desk. GFBio implements a sustainable infrastructure for preservation, integration, and publication of biological data and is a central part of the National Research Data Infrastructure (NFDI) for biodiversity: NFDI4BioDiversity [3].
GFBio and NFDI4BioDiversity support researchers, so their data are (1) enriched with metadata during manual curation, (2) long-term archived, (3) fully citable and (4) interconnected independent of type (environmental, biodiversity and sequence data). NFDI4BioDiversity is further implementing a common infrastructure for the diverse biodiversity community: Public agencies, learned societies, citizen science initiatives and research projects are guiding the development of additional services. Increasing the access to and interoperability of these diverse data sources and data types, scientists will find an increasingly rich environment of reusable, interconnected data with matching tools for research and teaching.

References: [1] Wilkinson et al. 2016, doi: 10.1038/sdata.2016.18; [2] Diepenbroek et al. 2014, In: Plödereder E, Grunske L, Schneider E. & Ull D (eds), Informatik 2014. Bonn: Gesellschaft für Informatik e.V., [3] Glöckner et al. 2020, doi: 10.5281/zenodo.3943645

13-P-07 - Climate change-induced phenological shifts extended the growing period and increased drought stress for broad-leaved trees at low elevations in Switzerland

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Climate change alters bioclimatic conditions during the growing period of trees directly, but also indirectly by causing shifts in leaf phenology in spring and autumn that lead to changes in the timing and length of the growing period. For example, climate change can directly cause changes in bioclimatic conditions through increased temperatures, even if neither the timing nor the length of the growing period changes. In contrast, climate change may cause phenological shifts that result in cooler or warmer days and wetter or drier days being included in the growing period, therefore indirectly changing bioclimatic conditions.
In our recent analysis of 49,088 leaf unfolding and leaf colouration data of beech, horse chestnut, rowan, sycamore, larch and spruce (leaf unfolding only) from Switzerland, observed between 200 and 1900 m a.s.l. during 1961–2018, we found that the overall lengthening of the growing period was mainly driven by shifts in leaf colouration. Furthermore, climate change significantly increased the intensity of drought during the growing period (based on the number of days with negative water balance) for most species, reaching +6.7 days/decade at low elevations. Interestingly, phenological shifts amplified the trends towards drier conditions by up to +81 % at low elevations for beech, rowan and sycamore, but weakened them by up to -84 % at high elevations for beech, rowan, sycamore and larch. Corresponding trends not only differed between species, but also changed with elevation. These results thus indicate a strong increase in drought stress, especially at lower elevations. Furthermore, we concluded that the future forest net ecosystem productivity in Central Europe will strongly depend on elevation and species composition, despite a general extension of the growing period for trees.

Reference: Meier M, Vitasse Y, Bugmann H, Bigler C. 2021. Phenological shifts induced by climate change amplify drought for broad-leaved trees at low elevations in Switzerland. Agricultural and Forest Meteorology 307:108485

13-P-08 - Communication of climate change impact modelling and uncertainty analysis for decision-making support and adaptation to change

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The German North Sea coast is characterised by continuous dikes and below sea level elevation of a big share of the terrestrial land. The system is vulnerable to climate change and specifically to predicted increase in sea levels and extreme weather events and changes in seasonal precipitation. Therefore, adaptation measures to the predicted change in pressures in the area is needed.

Within the inter- and transdisciplinary project RUINS (Risk, Uncertainty and Insurance under Climate Change - Coastal Land Management on the German North Sea) multiple ecosystem services are assessed through a chain of models that integrate climate change impact predictions and eco-hydrological modelling. As key example, scenarios for the ecosystem service water flow regulation is modelled and assessed. In order to communicate the complex model results and the related uncertainties of the projected future scenarios, the interaction between the key variables is represented in a Bayesian Belief Network (BBN) that shows the relations and assesses the conditional probabilities between the different states (scenarios) of the variables and their impact on the final ecosystem service.

The uncertainty of the modelled variables is systemically analysed and quantified and also included within the BBN in order to represent the conditional probability between the variable states and uncertainties. This provides a key communication paradigm that highlights the uncertainties of the projected future states in relation to their probabilities as key consideration in the decision-making process. The susceptibility to risk and uncertainty of the decision-makers also plays a key role in the implementation process and is included in the BBN as impacting factor. A web application, which enables policy makers to access the effect of modelling scenarios on ecosystem services and their uncertainties is in development, based on the results of the study.

SESSION 14

Dimensions of Diversity - Macroecological Avenues from Traits to Ecosystems

CHAIRS: ***Christian Hof, Holger Kreft***

While the GfÖ celebrates its 50th anniversary in 2020, the GfÖ specialist group for macroecology is still in its teenage years - founded in 2007. However, its growth and development over the last 14 years mirrors the vibrant dynamics of the field, from species richness patterns via macroevolutionary and biogeographical processes towards trait-based and ecosystem-focused approaches. Following this years theme of the GfÖ annual meeting, Ecology Science in Transition, Science for Transition, our session aims to bring together contributions that represent the multitude of diversity dimensions and macroecological avenues that make up the fields current state of the art. Thereby, we invite submissions from all sub-fields of macroecology. While either empirical, conceptual, or methodological studies are welcome, integrative presentations will be given priority, i.e. talks or posters that integrate different diversity dimensions, methods, taxa, data types, as well as spatial and temporal scales.

14-O-01 - A simple null model predicts the island rule

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The island rule is a putative pattern in island evolution, where small species become larger on islands and large species become smaller. Despite decades of study, a mechanistic explanation for why some taxonomic groups obey the island rule, while others do not, has yet to be identified. Here, we explore whether the island rule might result from evolutionary drift. We derived a simulation model that predicts evolutionary size changes on islands based on random evolutionary trajectories along bounded trait domains. The model consistently predicted the island rule and could account for its occurrence in plants inhabiting islands in the Southwest Pacific. When support for the island rule was not detected, insular gigantism was often observed, suggesting that natural selection was at work. Overall results indicate that evolutionary drift can provide a parsimonious explanation for the island rule, suggesting future work should focus on circumstances where it does not occur.

14-O-02 - A trait-based guide to test for assembly processes in island communities: community trait means, functional diversity and trait spaces

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Island communities rely on constant immigration from a source pool to maintain their diversity. However, not all species are equally well adapted to colonise an island. For some species their ecological strategies do not match the islands abiotic and biotic conditions and are filtered out of the pool of potential colonisers. Which species establish on an island is subject to intensive research, but there is evidence that functional traits play an important role in determining species ability to pass the islands abiotic and biotic filters. Especially community trait means (CM), functional diversity (FD) and trait spaces are promising tools to test for filtering and to understand whether island communities are functionally different to the source pool and why. We propose a trait-based framework based on CM, FD and trait spaces to disentangle the nature, direction and strength of filters on island communities. We illustrate how CM, FD and traits spaces change along island area using a dataset of three traits linked to dispersal (seed mass), competition (plant height) and climatic adaptations (leaf area) for 33 islands in Western Australia. We investigate how CM and FD relate to island area and compare it to traits from the source pool. We found strong support for filtering on the islands, expressed by a shift from communities with large seeds and small leaves on smaller islands to small seeded and larger leaved communities on larger islands, which also supported higher FD of seed mass and leaf area. CM and FD of seed mass and leaf area differed remarkably from those of the source pool indicating strong selective forces operating between source pool and island communities. In contrast, FD and CM of tree height were not affected by island area. In summary, we offer a fresh perspective on the newly emerging discipline of functional island biogeography by showing how trait amplitudes can be linked to filtering processes.

14-O-03 - Island characteristics shape the trait spaces of island bird communities

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The equilibrium theory of island biogeography (ETIB) predicts island species richness patterns based on immigration and extinction processes, which are influenced by island characteristics (e.g. isolation and area). Recently, the rise of trait-based approaches has been influencing the field of biogeography, including the ETIB. For example, trophic characteristics and dispersal traits should influence the likelihood of species to colonize islands, i.e. whether they can get to the island and maintain a population. Here, we present an analytical framework that integrates various traits in a multi-dimensional trait space and links them to the predictions of the ETIB and its trait-based extensions.

Using the bird communities of the world's islands as a study system, we used eco-morphological traits as surrogates for resource acquisition and dispersal characteristics. Traits information were compiled from museum specimens, public databases, and the literature. Information on species distributions and geophysical island characteristics were also compiled from published databases.

Our final dataset contained 2.013 species of terrestrial birds occurring on 1.738 islands larger than 1km². Our results show that dispersal ability (as indicated by ecomorphological traits related to dispersal) increased with increasing isolation. Furthermore, the average trophic level increased with island size and decreased with island isolation, suggesting that the occurrence of species on small islands is mainly limited to species from lower trophic levels.

Overall, these and other results provide general insights into the determinants of the variation of trait spaces among different island bird communities and thus to a better understanding of the variation of functional diversity on islands in general.

14-O-04 - Habitat islands in an arid "ocean": relative importance of different spatial characteristics on species richness and percentage endemism

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Habitat islands on special soils in arid regions offer unique edaphic conditions for plants. As a result, they often harbour specialised and endemic rich floras that show adaptations to the local soil chemical and physical properties. Besides these edaphic factors, habitat islands are characterised by distinct spatial features. However, their contribution as drivers of local biodiversity is still unclear. Therefore, we quantify to what extent size, shape, isolation, habitat diversity and the surrounding matrix explain the plant diversity of habitat islands. The quartz islands of our study area in the Knersvlakte Nature Reserve (Western Cape, South Africa) are isolated patches covered by whitish quartz gravel within a zonal semi-arid Succulent Karoo vegetation matrix. They are characterised by many local-endemic and habitat specialised plants, most of which are small succulents. We sampled the entire perennial flora of 47 of these unique and natural habitat islands and calculated their species richness as well as their percentage of endemic and habitat-specialised species. Spatial island characteristics were analysed via classification of satellite imagery. We used generalised linear models (single- and multi-predictor) to test for the relative importance of the spatial variables explaining the plant diversity of these habitat islands. The results of this study contribute to the debate on the extent to which island biogeographical theories can be applied to natural, edaphically unique habitat islands.

14-O-05 - Seasonal variation in the ecology of tropical cavity-nesting Hymenoptera

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Insect communities vary seasonally with changing climatic conditions and related changes in resource availability, competition or pressure by natural antagonists. But seasonal dynamics, especially in tropical-mountain ecosystems are not well investigated. We analysed temporal patterns of nest-building activity, ecological rates and life-history traits of cavity-nesting Hymenoptera in relation to seasonal climatic variation and elevation. We installed trap nests over 25 sites varying in flower availability and elevation. We exploited the potential seasonality in the cavity-nesting ecology of bees, caterpillar-hunting wasps and spider-hunting wasps over a complete annual period covering two rainy and two dry seasons. Nest-building activity showed strong seasonal trends in bees, caterpillar-hunting wasps and spider-hunting wasps. Furthermore, nest-building activity was considerably higher and seasonal trends were more synchronised between functional groups at low elevations. We also detected seasonal patterns for sex ratio and development time, parasitism and natural mortality rates, which varied with functional groups and elevation. Temperature, relative humidity, an interaction of both and flower abundance were important predictors for seasonal patterns in nest-building activity, ecological rates and life-history traits. Finding these links between climate, resources, ecological rates and life-history traits indicate high sensitivity of plant-host-antagonist interactions to environmental changes.

14-O-06 - A global analysis of community stability across freshwater and terrestrial realms

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Determining the drivers of community stability is an important challenge given ongoing environmental change. Theoretically, community stability is expected to increase with species richness, and decrease with synchrony. However, patterns of synchrony do not consider the asymmetric interactions between species in a changing extreme environment. The interspecific interactions become asymmetric if species are synchronous when they are simultaneously rare (asymmetry in lower tail) or abundant (asymmetry in upper tail). We determine if including patterns of asymmetry in synchrony improves our ability to predict stability across realms. Specifically, we compare a null model of the commonly considered drivers of community stability, species richness, and biomass variation (variance ratio), with a model that includes measures of asymmetric interactions. Using >2700 time series of global community composition we show that the freshwater realm is less stable than the terrestrial realm. We find a higher synchrony:asynchrony ratio (positive vs. negative pairwise interactions) for freshwater than terrestrial communities. We also find stability is better predicted considering the effect of realm and asymmetric interactions between species at their either extremes. We conclude that the asymmetric interactions between species, make freshwater communities more synchronous, and as a result less stable, than terrestrial communities. Considering asymmetric interactions will allow us to better understand how communities will respond to ongoing global change, and as such, refine management recommendations.

14-O-07 - Broad-scale patterns of geographic avoidance between species emerge in the absence of fine-scale mechanisms of coexistence

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The need to forecast range shifts under future climate change has motivated an increasing interest in better understanding the role of biotic interactions in driving diversity patterns. The contribution of biotic interactions to shaping broad-scale species distributions is however, still debated. We aim to test whether spatial exclusion between potentially competing species can be detected at the species range scale, and whether this pattern relates to fine-scale mechanisms of coexistence. For that, we develop and evaluate a measure of geographic avoidance that uses outputs of species distribution models. We apply the measure to 10 Palearctic bat species in which competition is likely to occur and compare outputs to null models based on pairs of virtual species and to expectations based on ecological similarity and fine-scale coexistence mechanisms. Values of geographic avoidance were above null expectations for two cryptic species pairs which also showed the highest levels of ecological similarity and no trophic or habitat partitioning. Our results support the role of interspecific competition in limiting the geographic ranges of morphologically similar species in the absence of fine-scale mechanisms of coexistence. This study supports the importance of incorporating biotic interactions into predictive models of range shifts under climate change.

14-O-08 - Environmental conditions drive the potential biotope composition in Bavaria

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Biotopes are characterized by a specific species composition and often high biodiversity. Because diversity is threatened by anthropogenic climate and land-use change, recently, several studies investigated the distribution of biotopes. Most studies analysed only single biotopes or coarse spatial scales. However, local land-use decisions require information on the distribution and composition of biotopes on a finer scale. Based on data from the Bavarian biotope mapping program and environmental variables covering climate, soil chemicals and soil physical properties, we estimated the distribution of 29 biotopes belonging to 3 biotope types (grassland, bushland, forest) using the distribution algorithm Maxent. We found that climate variables were generally more important for the biotope distribution than soil variables. Furthermore, the importance of environmental variables differed more among biotopes than among biotope types. After modelling the potential distribution of the individual biotopes according to the environmental conditions, we stacked these predictions to assess the potential biotope composition over Bavaria. The resulting composition map showed that approximately 8% of Bavaria was not suitable for any biotope and 25% not suitable for more than two biotopes. Further, the same biotopes were often predicted for larger areas. By providing the potential biotope composition and its drivers, we could extend the knowledge on the distribution of vegetation offering the possibility to evaluate biotope richness and develop environmental risk assessments.

14-O-09 - From niches to biomes: integrating a process-based niche model for plants and botanical big data for projecting largescale ecosystem change

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Global databases on plant species distributions and traits allow ecologists to parameterize process-based niche models for thousands of species using inverse modelling strategies. We demonstrate that a physiological niche model parametrized this way has good transferability, which is a desired property for projecting climate change impacts on plant growth and species distributions. We then fit the niche model for thousands of plant species of different growth forms, which reveals distinct spatial attractors for growth forms that agree well with biomes. We show macroecological applications of the workflow, including projections of biome shifts and novel ecosystem under different climate change scenarios. The integration of physiological niche models and botanical big data provides an opportunity for macroecologists to scale up from fundamental biological processes to global ecosystem distributions and dynamics.

14-O-10 - Global changes in terrestrial, freshwater, and coastal ecosystem extents over three decades

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Land use, climate change, and other pressures cause global changes in the extents of different ecosystems, altering Earth System functioning and driving widespread changes in species distributions, community composition, and other ecological patterns. The IPBES Assessments recently reported that most natural and seminatural ecosystem types, from tropical savannas to alpine wetlands, are globally and regionally declining. Yet, for most ecosystems and world regions, systematic data on direction and magnitude of changes are lacking, leaving the generality of declines unclear. Integrating three decades worth of environmental Earth observations (incl. >40 satellite-based and in-situ datasets), we provide an unprecedentedly comprehensive record of global dynamics in land, freshwater, and coastal ecosystem types over 27 years. We find that ecosystem extents are generally highly dynamic. Globally, an area larger than China and India combined experienced changes in locally dominant ecosystem types. Artificial ecosystems like pastures, plantations, and mining areas increased substantially, mainly at the expense of sub-/tropical lowland moist forests. Yet, surprisingly, global and regional extents of different (semi-)natural ecosystems did not decline systematically over recent decades. Instead, they exhibit regional gains and losses, and common shifts between upward and downward trends, but no net loss on average. This apparent paradox is explained by few, globally extensive and declining ecosystems making room for areal increases in many less extensive (semi-)natural ecosystems, notably including most wetland types, as well as in artificial systems. Our results may inform final discussions within the UN Convention on Biological Diversity (CBD) on ecosystem targets and baselines for the Post-2020 Framework, while the new data can help improve national monitoring capacity and enable diverse applications to better understand, anticipate, and address global ecosystem changes.

14-O-11 - Does paleo-climate drive the evolution of climatic niches? Insights from a passerine bird clade

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Climatic niches describe the climatic conditions in which species can persist. Shifts in climatic niches have been observed to coincide with major climatic change, suggesting that species adapt to new conditions. Therefore, paleoclimatic conditions are expected to drive rates of climatic niche evolution through time. We test this relationship for 65 Old-World flycatcher species (Aves: Muscicapidae), by combining niche quantification from present-day distribution data for all species with a dated molecular phylogeny to infer changes in the rates of niche evolution for temperature and precipitation niches over the history of the clade (approximately the last 18 million years). Paleoclimatic conditions for the same timeframe were inferred independently using two datasets: a paleoelevation reconstruction and the mammal fossil record. We find changes in climatic niches through time, but no or weak support for a relationship between niche evolution rates and rates of paleoclimatic change. In contrast, the inferred relationship between climatic conditions and rates of niche evolution depends on paleoclimatic reconstruction method: rates of temperature niche evolution are significantly negatively related to absolute temperatures inferred using the paleoelevation model but not to those reconstructed from the fossil record. We suggest that paleoclimatic change might be a weak driver of climatic niche evolution in birds and highlight the need for greater integration of different paleoclimate reconstructions.

14-P-01 - Long-term occupancy trends across three insect taxa and their relationship with ecological traits

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Changes in climate and land-use are considered to have considerable impacts on different levels of biodiversity, associated with population declines, range shifts, and changes in species communities. Most studies investigating such biodiversity trends are limited by a lack of reliable fine-scale, long-term field data, especially in highly heterogeneous regions. In Central Europe, heterogeneous areas are affected by different human pressures acting at different scales and changing over short spatial distances, which increases the need for fine-scaled assessments of biodiversity trends. The state of Bavaria in southern Germany includes a diverse mixture of landscapes and habitats, ranging from lowland forests and floodplains to alpine environments. Therefore, Bavaria may serve as a model region for pressures on Central European biodiversity.

We present long-term trends in three ecologically and physiologically different insect taxa (butterflies, dragonflies, grasshoppers), based on 40 years of survey data. We analyse the data using occupancy models to obtain reliable population trends, and link these trends to species' traits, indicating possible drivers of change. While cold-adapted species decline, there is a significant increase in warm-adapted species across taxa, which may indicate that climate warming has already affected the Bavarian fauna. In contrast, in terrestrial taxa habitat specialists show slightly decreasing trends, while dragonflies show no difference between habitat generalists and specialists. This might be an effect of improved habitat quality for aquatic insects.

Our results emphasize the need for systematic, reliable assessments of the effects of human pressures on different levels of biodiversity. Understanding past influences of climate and land-use change on species is the first step towards the mitigation of increasing human pressures on biodiversity in the future.

14-P-02 - Multidimensional trait response drives assembly processes of edaphic microarthropod communities in grasslands

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Identifying community assembly rules in soil communities is important for developing new strategies to conserve soil biodiversity and to maintain ecosystem functions.
We performed hierarchical community assembly modelling to identify the proportional contributions of dispersal assembly, environmental filtering, and limiting similarity in the three geographically distant regions of the DFG Biodiversity Exploratories (Germany). Concerning Collembola, environmental filtering by intensive grazing turned out to be the dominant process explaining most of the local metacommunity structure in Schorfheide-Chorin and Hainich-Dün grasslands, but not in Schwäbische Alb. Environmental filtering shaped a high proportion of collembolan metacommunities in unfertilized but not in heavily fertilized grasslands. Assembly processes of soil-dwelling Oribatida communities in Schorfheide-Chorin contrasted from these patterns in being less stochastic but more related to niche-based processes. RLQ analyses on underlying trait responses revealed some region-specific relationships between traits and the intensity of grazing or fertilizer application, but no strong consistent patterns or significant effects of these two management practices on individual trait characteristics. Functional diversity indices show that grazing decreases the functional dispersion of Collembola communities, i.e. functionally similar species increased in abundance. Springtail functional richness, however, was positively correlated with fertilization intensity.
We conclude that assembly processes of edaphic microarthropods are mainly driven by multidimensional niche-based response of traits to the intensity of grazing and fertilization, but not by single trait response. Thus, only the combination of classical trait-based approaches with hierarchical assembly modelling allows a comprehensive understanding of the response of soil microarthropod communities to grassland management.

14-P-03 - Integrating species traits and interactions to analyze ecosystem functions

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Understanding the mechanisms that determine ecosystem functions is urgent given the current deterioration of ecosystem functions and services. This task is particularly challenging for functions mediated by trophic interactions, which, have generally been explored by either analyzing species trait diversity or species interactions. However, ecosystem functions emerge from the interplay between the resource and consumer traits related to a given function, the frequency of interactions among species that perform this function, and the degree of redundancy among species contributing to this function. Here, we propose the interaction functional space (IFS) as a concept that integrates trait diversity and species interactions in the context of multi-trophic ecosystem functions. We exemplify the method to employ the IFS using empirical data on the seed dispersal function along an elevation gradient in Mt. Kilimanjaro, but our approach can be applied to any trophic ecosystem function. We find that the expression of the function shifts across the gradient is broader at low elevation and concentrated at mid-elevations. We also find that a high trait diversity of plants or birds does not necessarily imply a high functional richness of the IFS of the function. In addition, we show that the simultaneous effects of traits and interactions influence the species contribution to the function. Finally, we explain how different IFS configurations may help clarify why there is no consensus on the ubiquity of relationship between trait diversity and different ecosystem functions. We discuss how the effects of species loss depend not only on its traits but also on the role and strength of species interactions as summarized in the IFS. We argue that by integrating the effect of traits and interactions in the IFS we can better illuminate the macroecological dynamics of ecosystem function in space and time and predict resistance of ecosystem functions to species loss under global change.

14-P-04 - Species distribution modelling of selected grasshopper species in Europe and Bavaria

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Land use and climate change cause declines in populations and distributions of many insect species, such as grasshoppers (Orthoptera). To understand these trends and to develop projections of future range shifts, species distribution modelling (SDM) is a popular approach. However, the uncertainties of SDMs are well-documented, too. Here we assess some of them, specifically we try to answer the questions of (1) whether accurate predictions are possible even with simple approaches, (2) whether model outcomes and performances differ between different scales, and (3) how land-use and climatic variables differ in their importance as factors influencing the distribution. To answer these questions, we conducted SDMs at the continental (European) and the regional (Bavarian) scale under current conditions for the grasshopper species *Chorthippus apricarius*, *Phaneroptera falcata*, *Phaneroptera nana* and *Psophus stridulus.* We found that while the models were often accurate (indicated by high values of model performance measures), their outcomes depend strongly on a variety of factors such as the species in question, the scale level, the input data, the modelling algorithms, and the selection and implementation of model parameters. We also found that even though land use does not necessary enhance model performance, there may be reasons for including it, depending on the purpose of the study.

14-P-05 - A trait-based approach to modelling the loss of mudflats due to climate change induced sea level rise on waders in the Wadden Sea

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The Wadden Sea is the most important stopover for waders on their migration along the East Atlantic Flyway. In this environment, they can gain enough energy for their migration to their breeding and wintering grounds. A rise in sea level is one of the most serious consequences of climate change (IPCC 2019). For many waders in the Wadden Sea, such a change can have serious consequences, as they are dependent on the dry mudflats and shallow water areas for their foraging.
Based on the literature, the species Dunlin, Oystercatcher, Eurasian Curlew, Bar-tailed Godwit and Redshank were characterised as model species with the functional traits of leg length and trait-based feeding behaviour. ESRI ArcGIS was chosen as the modelling environment and the parameters bathymetry, sediment composition and mussel bank coverage were selected to describe the intertidal flats. Using the leg-length model and the bill-based behaviour, the area sizes of available foraging habitats were calculated for different sea level rise scenarios (current, +0.25, +0.5, +0.8 and +1.10 m) over the tidal period.
The models demonstrated that the intertidal mudflat habitat as a primary feeding ground for waders decreased with rising sea level for all species. For shallow water, the leg-length model showed that each species had a different size of foraging area. With a constant morphology of the areas, this feeding area increased up to a sea level rise of 0.8 metres. A decrease was only found for the scenario of a 1.10 m higher sea level. This is due to the fact that a higher sea level meets a steeper morphology. From the trait-based models of feeding behaviour, the important role of shallow water microhabitats at the tidal edge for specialised species became clearer. This is due, for example, to the pincette-like shape of the Dunlin's bill, with which it prefers to forage in the wet microhabitats of the tidal flats. Consequently, a steepening morphology could have an additional impact on populations.

14-P-06 - The role of nutrient supply in the relationship between genome size and growth efficiency

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Genome size, i.e., the total amount of nuclear DNA per cell, is known to vary greatly across organisms, in angiosperms >2,400-fold. Despite a wealth of studies on genome size, the evolutionary drivers and the consequences of such extreme diversity in genome sizes are still challenging scientists. Observed correlations between genome size and cellular traits led quite early to the assumption that genome size variation carries functional consequences. At the cellular level, an obvious correlate of increased genome size is increased cell size, which in turn is generally associated with reduced metabolic and division rates. Since these traits are directly linked to growth, genome size may be negatively correlated with relative growth rate. We here present (I) results of a recent study, in which we investigated the relationship of genome size and relative growth rate (RGR) in two sub-families of epiphytic bromeliads. This work revealed an unexpected positive relationship between RGR and genome size. We attributed this result to high nutrient supply during cultivation, and put forward the hypothesis that: "*The relationship between genome size and growth efficiency, i.e. relative growth rate, depends on nutrient supply.*" This hypothesis will be explicitly addressed in an upcoming and recently funded FWF project and we here present (II) the conceptual framework. Particularly, the planned research aims to reveal the underlying cellular, molecular and stoichiometric mechanisms shaping this relationship. Studying this hitherto unexplored and potentially general ecological concept will open a new field of investigation and a new level of understanding regarding the genomic base of physiological responses in plants. By providing information on responses of plants to different nutrient regimes, the research is also relevant in the view of global anthropogenic impact, particularly considering eutrophication and oligotrophication.

14-P-07 - Thermal tolerances and biogeography of Central European dragonfly species

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In the face of climate change, species reactions to varying temperatures are important to understand in order to predict their potential responses to temperature increases. As species range size is of key importance for species survival, its drivers are of particular interest for ecology, biogeography, and conservation. For dragonflies and damselflies, multiple drivers of range size have been identified previously, including ecological and life history traits (such as habitat preference or duration of the adult flight period). Temperature can influence some of these traits; for example, the timing of adult stages will advance with increasing temperatures in springtime. Here, we are particularly interested in the effects of temperature on species ranges, therefore we aim to assess the intra- and interspecific variation of experimentally measured thermal tolerances of damselflies (Zygoptera) and how these thermal tolerances correlate with attributes of the distributional range.
To do so, we will collect individuals of adult Zygoptera across the State of Bavaria. Different levels of thermal tolerance limits (maxima and minima) will be measured using a thermocycler. Distribution data will be compiled from the “Atlas of the European dragonflies and damselflies” by Kalkman *et al*. (2015). Environmental data like temperature, humidity and solar intensity will be measured at each collection site and day. With these data, we will assess whether the abiotic environment accounts for the intraspecific variance in Zygopteran thermal tolerance. Furthermore, we will test whether thermal tolerance range, average and limits correlate with characteristics of the European distribution, such as its size, average location or limits. We expect that species with larger thermal tolerance range will also have a larger range size. In our poster, we will present our conceptual approach as well as preliminary results.

14-P-08 - The influence of climate and land-use on dragonfly distributions at different spatial scales

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The importance of factors influencing and limiting species distributions varies at different spatial scales. While climate usually plays a dominant role at the larger scale, topography or land-use play an important role at smaller scales, with land-use and its intensity being particularly relevant as they determine the availability and suitability of habitats. To which extent this is a general pattern is, however, rarely tested, especially for insects for which the relevant data across scales is often not available.
Here, we examined the relative role of climate and land-use variables as determining factors of dragonfly distributions at different spatial scales (with Europe as the continental and the State of Bavaria as the regional scale level). In particular, we assessed whether and how different land-use variables influence the degree to which dragonfly species fill their climatically suitable range at the regional scale level.
To do so, we calibrated species distribution models (SDM) at the European scale level based on climatic variables for all 72 Bavarian dragonflies. To identify the potential range at the regional scale, we then projected the SDMs to the map of Bavaria and compared the potential with the actual distribution for each species. By overlaying these distribution maps with spatial data of land-use type and intensity, we quantified the differences in land-use between the actual and the potential distribution. Preliminary results indicate that land-use and probably mainly its intensity does influence dragonfly occurrences at the regional scale, as apparently the amount of broad-leaved forests is consistently larger in areas where the dragonflies do not occur despite a potentially suitable climate. These findings could be helpful to develop more detailed SDMs at the regional scale in order to guide the conservation of dragonflies.

SESSION 15

The Diversity of Soil Biota Processes, Functions and Ecosystem Services in Land Use Systems

CHAIRS: ***Martin Potthoff, Stefan Schrader***

Soil biota provides services that are beneficial to the productivity and sustainability of land use systems. This session aims to discuss how land use systems and its management practices affect soil biodiversity and how soil biodiversity feeds back to soil functions and ecosystem services. Soil biodiversity is immense but still we hardly understand what allows and what limits such a diversity in a somehow uniform habitat. Knowledge is mounting that a sustainable intensification of land use needs to include the conservation of processes and functions run by soil biota that are essential for self-preservation and self-regulation of soils. Hence, the contributions to this session should address (1) the strong progress in developing methods for biodiversity identification in soil and the quantification of biota specific impacts and (2) transversal interactions with socio-economical sciences that lead to the development of tools to assess soil management as a socio-ecological issue. This session will focus on the role of soil biology in delivering soil functions in systems formed by humans, e.g. agricultural (including grassland), forest or restored sites. The synergies and trade-offs that occur within the bundle of soil functions and management practices need to be identified to develop effective strategies for both sustainable land use and the protection of soil (biota) as an ecosystem.

15-O-01 - Bioregulation of *Fusarium* and its mycotoxins in maize residues by earthworms (*Lumbricus terrestris*)

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Mulching as a component of conservation tillage promotes the development and survival of soil-borne mycotoxin-producing plant pathogenic fungi such as *Fusarium* (ecosystem disservice), while also fostering soil biodiversity including antagonistic, fungivorous, and mycotoxin-degrading soil biota (ecosystem service). However, it is still largely unclear which ecosystem service/disservice balance results from both pathways and what role various key species within the soil fauna play in pathogen suppression and mycotoxin regulation. Against this background, the bioregulatory capacity of the widespread and common earthworm species *Lumbricus terrestris* in suppressing three economically relevant *Fusarium* species (*F. graminearum*, *F. culmorum* and *F. verticillioides*) and reducing their main mycotoxins (deoxynivalenol (DON), 3-acetyldeoxynivalenol (3-AcDON) and zearalenone (ZEN)) in maize mulch was analysed as part of the BiodivERsA project SoilMan, taking into account chop size. For this purpose, a mesocosm field experiment was carried out on a loam soil in a long-term reduced tillage field trial.

The results show that *Fusarium* regulation by *L. terrestris* was species-specific, encompassing the entire range from suppression (*F. graminearum*) to promotion (*F. verticillioides*). With respect to mycotoxin regulation, a significant increase in the degradation rates of all three toxins by *L. terrestris* was demonstrated. Within the present experimental design, fine chopping of the maize residues had no significant influence on the earthworms' bioregulatory capacity.

While the earthworm can thus shift the ecosystem service/disservice balance in either direction in terms of *Fusarium* regulation, it clearly shifts it in favour of ecosystem services in terms of mycotoxin regulation. The synergy of such natural bottom-up effects (bioregulation) and anthropogenic top-down effects (agricultural management) can, within the framework of adapted agricultural management, help to ensure long-term sustainable agricultural production on healthy soils.

15-O-02 - Ecosystem services during earthworm-controlled litter decomposition in annual and perennial energy plants

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Perennial energy crops improve sustainability in biogas production and support earthworm abundance and diversity. Earthworms trigger ecosystem services and potential disservices. But underlying processes and their implications for perennial energy cropping systems remain unclear.
We conducted a laboratory experiment to provide insight into ecosystem services and disservices during earthworm-controlled decomposition of annual and perennial energy crop litter. Anecic and endogeic earthworms were treated with wilted cup plant (*Silphium perfoliatum*) and maize (*Zea mays*) litter during incubations of 4 and 8 weeks. Decomposition and consumption rates were calculated, and C, N, and P contents in litter and casts were measured.
Both litter types were characterized by low nutrient contents and recalcitrant cell wall constituents leading to reduced litter mineralisation and low palatability for earthworms. Cup plant litter contained less N causing earthworms to accumulate only small amounts of N in their casts and to egest more excess C and P. Maize litter contained more N. Due to higher N availability, earthworms in maize treatments assimilated more C and P. Thus, cast N was slightly higher and cast C and P were slightly lower in maize treatment than in cup plant treatments.
Our results imply, that earthworms ingested more soil and fed on SOM, soil microbes and fungi to meet their nutritional demands. This change in feeding behaviour then triggered low cast nutrient contents. N limitation is assumed to be a key driver for cast nutrients.
Our findings underline the importance of litter quality in low-input perennial systems. Low-quality litter hampered mineralisation and nutrient turnover but potentially induced SOM decomposition. Therefore, it is crucial to maintain beneficial boundary conditions, i.e., undisturbed soils and adequate food sources to benefit from ecosystem services. Otherwise, earthworm-controlled decomposition may be shifted towards generating disservices.

15-O-03 - How energy crops (maize, cup plant, and field grass) affect soil microarthropods and their decomposition services

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An increase in the cultivation of annual energy crops such as maize (*Zea mays*) is assumed to decrease biodiversity in the agricultural landscape. In addition, the cultivation of such crops may lead to changes in soil properties. Thereby affecting the soil biodiversity and its ecosystem functions and services like soil microarthropod communities and their contribution to plant litter decomposition. On the other hand, perennial energy crops such as field grass (a mixture of *Festulolium*, *Dactylis glomerate*, *Loliuim perenne*, *Festuca pratensis*, and *Festuca arundinacea*) and cup plant (*Silphium perfoliatum*) are assumed to protect and promote soil biodiversity through less intensive management.
This study's main aim was to assess the effect of soil microarthropods on the litter of maize, field grass, and cup plant via decomposition using litter bags with two different mesh sizes (20 µm and 500 µm) for three months during the vegetation period. At the end of the experiment, a total of 55,464 soil microarthropods (73% mites, 25% collembola, and 2% others) were extracted from the litter bags. The diversity and abundance of soil microarthropods were higher under cup plant cultivation, followed by field grass and maize. The amount of litter loss was greater in grass than maize, followed by cup plant. Litter decomposition is greatly affected by litter quality. Low C: N ratio, lignin, and cellulose content promote faster mass loss and vice versa. The low C: N ratio (20:1) of grass compared to that of cup plant (39:1) and maize (40:1) might have led to this result. Lignin and cellulose content was higher in the cup plant, followed by maize and grass during the early stages of decomposition. The decomposition rate was higher in cup plant, followed by maize and field grass for both mesh sizes. The high decomposition rate was positively correlated to the diversity and abundance of soil microarthropods under cup plant cultivation. This result indicates a positive effect of the alternative energy crops cup plant and field grass on soil biodiversity. Cup plant, therefore, offers the possibility of more environmentally friendly agricultural bioenergy production.

15-O-04 - Multifunctionality of belowground food webs

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Belowground consumers create complex food webs that regulate functioning, ensure stability and support biodiversity both below and above ground. However, existing soil food-web reconstructions do not match recently accumulated empirical evidence and there is no comprehensive reproducible approach that accounts for the complex resource, size and spatial structure of food webs in soil. I build on generic food-web organization principles and use multifunctional classification of soil protists, invertebrates and vertebrates, to reconstruct "multichannel" food-web across size classes of soil-associated consumers. I then use food-web reconstruction, together with assimilation efficiencies, to calculate energy fluxes assuming a steady-state energetic system. Based on energy fluxes, I describe a number of indicators, related to stability, biodiversity and multiple ecosystem-level functions such as herbivory, top-down control, translocation and transformation of organic matter. The multichannel reconstruction can be used to assess trophic multifunctionality (analogous to ecosystem multifunctionality), i.e. simultaneous support of multiple trophic functions by the food-web, and compare it across communities and ecosystems spanning beyond the soil. With further validation and parametrization, the multichannel reconstruction approach provides an effective tool for understanding and analyzing soil food webs. I believe that having this tool will inspire more people to comprehensively describe soil communities and belowground-aboveground interactions. Such studies will provide informative indicators for including consumers as active agents in biogeochemical models, not only locally but also on regional and global scales.

15-O-05 - Land use intensity of grasslands affects the taxon-specific resilience of soil fauna communities after pulse stress

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Grasslands in Germany hold an important part of soil biodiversity. They are maintained by periodic disturbance, but agricultural intensification exposes these systems to increasing stress by causing persisting changes in soil chemical and physical properties. The resistance and resilience of edaphic grassland communities to periodic disturbance (pulse stress) and the modulation of these responses by long-term changes in land use intensity (press stress) have rarely been addressed.

We conducted a field experiment using experimental pulse disturbance as a tool for obtaining a better understanding of the processes controlling biodiversity, community assembly, and functioning of soil fauna at 36 grasslands along a land use management gradient in the three regions of the Biodiversity Exploratories: Schwäbische Alb, Hainich-Dün, and Schorfheide-Chorin. Two levels of soil compaction (50 and 500 kPA simulating tires of field machinery and cattle, respectively), one fertilizer treatment (160 g m^{-2} organic fertilizer), and a control plot were established at each grassland. Soil fauna was sampled four times: immediately after pulse stress application, three weeks, six months, and two years later. We hypothesized that changes in the community structure of different taxa are disturbance-specific due to different changes in soil conditions and that press stress may select for taxa with low sensitivity to pulse stress.

Abundance data analysis at coarse taxonomic level revealed that the response to soil compaction, which tremendously decreased total abundances, was not only taxon-specific, but also highly dependent on regional soil characteristics and land use history. Fertilizer application stimulated some taxa over a short- or medium-term period, depending on the regional, and land use history context. General trends, however, suggest that edaphic grassland communities recover fairly quickly from pulse stress, while their resilience levels depend on soil characteristics and long-term land use intensity.

15-O-06 - Tree diversity effects on litter decomposition are mediated by litterfall and microbial processes

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Forest ecosystems are critical for carbon fixation in both above- and belowground compartments. Increasing tree diversity enhances forest productivity and litter decomposition processes. Litter decomposition is carried out by soil organisms; however, in subtropical forests where soil meso- and macrofauna abundances are rather low, we expected most of the litter decomposition process to be driven by microorganisms. In addition, there is evidence that litter diversity increases litter decomposability. However, how tree diversity affects decomposition by modulating the amount of litterfall and its composition, has not been tested yet.
We studied tree diversity effects on decomposition as well as the role of soil microbes and litter decomposability in this process in a large-scale tree diversity experiment of subtropical China (BEF China). Moreover, we tested how leaf functional traits, tree biomass, and the forest spatial organization drive the amount of litterfall and litter composition.
Our results show that tree species richness increased the amount of litterfall and litter species richness. We show that species-specific litterfall is driven by tree biomass and leaf functional traits (i.e., SLA, LDMC, carbon and nitrogen content) and decreases with increasing distance to the tree. The spatial distribution of the litterfall increases the spatial heterogeneity of litter distribution in the plot and thus influences litter decomposability and, thereby, microbial litter decomposition. We demonstrate that soil microorganisms are responsible for a large proportion of litter decomposition in this subtropical forest. These findings highlight the key role of tree diversity and cascading effects on different ecosystem properties in driving forest carbon and nitrogen cycles. The identified mechanisms can help to improve models on biogeochemical cycles.

15-O-07 - Soil microbial diversity is crucial for plant health throughout plants lifecycle

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Biodiversity in the soil is linked to nutrient cycling and ecosystem health. This has a direct impact on plant health and performance. Microbes colonize not only soil and plant roots, but also other plant tissues, making them an important element of the plant lifecycle. A plant-species-specific microbiome with mainly plant-beneficial strains is transmitted across generations via seeds or other tissues, e.g. sporophytes. In addition, plants were shown to attract environmental microbes from the soil. This is how plants can adapt to certain environmental conditions. By enriching specific microbial taxa in microhabitats, e.g. root, leaf, flower and fruit, a specialized defense barrier against pathogen threads is formed. These specialized communities can also be transmitted along plant development and throughout postharvest. By enhancing the microbial biodiversity in the soil, plant associated communities can be shaped and fruit and vegetable quality can be influenced. After all, soil biodiversity is not only crucial for plant health but also key for human and planetary health.

15-O-08 - How (well) does European policy protect soil organisms. Challenges of protecting European belowground biodiversity beyond productive systems

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Belowground biodiversity has been linked to many ecosystem functions and services related to human health and wellbeing, while facing threats similar to the aboveground system. However, soil biodiversity has been neglected in most global biodiversity assessments and conservation actions. To better understand how and why soil biodiversity and related ecosystem functions have lesser priority for nature conservation, we reviewed the current status of soil protection: by (i) summarizing past and current soil-related policies that form the basis for nature conservation with focus on Europe, (ii) investigating the effect of current conservation efforts as represented by European nature conservation areas, and (iii) revealing the role of soil in conservation management based on the example of German management plans for nature conservation areas.
In accordance with previous studies, we found soil-related policies to still be insufficient for the protection of soil biodiversity. Respective policies are mainly addressing soil contamination in agricultural systems, being of low-binding nature, and most importantly not highlighting soil nature conservation goals but rather other environmental objectives. Accordingly, we demonstrated that soils in European nature conservation areas generally do not perform better in terms of their ecosystem functioning, independently of the land-cover type or ecosystem function considered. In Germany, we found that management in nature conservation areas has failed to address soil conservation adequately. Management plans did not show high regard for protecting belowground biota as they do for other organism groups such as birds or plants. Specifically, soil is generally regarded in its role as habitat for aboveground organisms, but not for its own biodiversity. To overcome the issues resulting from knowledge gaps and negligence, we have to bring soil biodiversity more prominently on the political agenda and implement its effective protection.

15-P-01 - The restoration of nutrient-poor agricultural soils and their potential to foster (soil) biodiversity

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Nutrient-poor agricultural soils were once common, but are rare nowadays as intensive fertilization over the last 50 years successfully increased soil productivity in agriculture. Restoration of nutrient-poor agricultural soils following open-cast lignite mining provides unique opportunities for nature conservation. We will show examples of the richness of the soil and aboveground diversity in nutrient-poor recently reclaimed agricultural sites and will discuss the potential of soil chronosequences after mining to study transitions of soil microbial stoichiometry during soil development. The data show that soil biodiversity is not necessarily linked to soil organic matter contents.

SESSION 16

Drylands in Transition

CHAIRS: ***Anja Linstädter, Liana Kindermann, Niels Blaum***

In global drylands which comprise arid, semi-arid and dry subhumid ecosystems, plant growth is mainly limited by low and highly variable precipitation, mostly constraining human activities to livestock production. Thus, livelihood security in drylands relies heavily on forage provision and on other ecosystems services from vegetation. Drylands are also among the most sensitive areas to global environmental change. Increasing land-use pressure and climate change massively threaten ecosystem health and productivity, with negative consequences for local livelihoods and well-being. Although there is ample evidence that climate and land-use may have interactive effects on ecosystems, we still lack a mechanistic understanding how these two global change drivers both separately and jointly affect biodiversity, and, subsequently, ecosystem functions and services. This session calls for studies targeted at a better understanding of transitions in dryland ecosystems triggered by global environmental change. We invite observational studies, experimental studies and modelling approaches dealing with the effects of climate change and/or land-use change on dryland ecosystems. We particularly welcome studies on rapid transitions in drylands due to tipping point phenomena, as well as studies on changing management regimes such as transitions between livestock-based and wildlife-based strategies. This session is also the annual meeting of the Working Group "Dryland Research" within the Ecological Society.

16-O-01 - Namibian rangelands in transition: Towards sustainable herbivore compositions for savanna management

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The world's savannas have been utilized as rangelands for centuries, providing livelihoods for thousands of people. Intense livestock production and fire suppression destabilize the natural savanna systems since decades. The resulting shrub encroachment is threatening productivity, biodiversity, and other ecosystem services. As a result, in Namibia, a rethinking of land-use options leads to a shift towards wildlife-based land-use. Wild herbivores are assumed to provide a more natural pressure on the vegetation and also have good economic value. However, under which conditions this is actually ecologically sustainable remains largely unclear. By developing and applying a large-scale dynamic savanna vegetation model which considers ecohydrological processes, fire, and herbivore grazing and browsing in aggregated herd groups, we evaluate the effect on vegetation stability, productivity, and biodiversity. Findings show that mixed grazer and browser systems can lead to long-term availability of plant biomass as fodder resource, a stable overall tree cover, and implicate high biodiversity. By disentangling the interrelation of herbivores, fire, and vegetation, we can show how beneficial fire sizes and frequencies emerge naturally by appropriate biomass consumption by herbivores. A composition of herbivore functional types as present in historical wildlife communities in the study area, consisting of approximately 40% browsers and 60% grazers, can lead to high productivity and diversity at once. Based on this, a shift towards wildlife-based land-use may conserve open savanna landscapes and ensure their long-term productivity.

16-O-02 - A dynamical systems approach to bush encroachment: Increasing farmer investment leads to bistability and increases the susceptibility of savannas to drought

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Savannas are characterized by the coexistence of two contrasting plant life-forms: shrubs and grasses. During the last decades, there has been a global trend of an increase in woody cover and the spread of shrubs and trees into areas that were previously dominated by grasses. This process, termed bush encroachment, is driven by unsustainable grazing management with high livestock densities. It is furthermore associated with severe losses of ecosystem functions and typically more than challenging to reverse. Looking at savannas through the lens of dynamical systems theory can help to understand the drivers of bush encroachment in more detail. We use a set of coupled differential equations to describe the interactions between shrubs and grasses, as well as two types of herbivores, namely grazers and browsers. Grazers receive a certain level of care from farmers, meaning that grazer densities depend on the level of farmer investment. Despite its simplicity, the model successfully reproduces several patterns known from empirical observations and allows us to disentangle the underlying (de-)stabilizing forces. In particular, we show that bistability emerges in response to increased farmer investment and that drought events trigger abrupt transitions from a grass dominated to an encroached state. We also show that with increasing farmer investment the system becomes more susceptible towards droughts, meaning that even a minor drought is then severe enough to push the system towards encroachment.

16-O-03 - Wildlife in favor for a healthy savannah state - a model-based comparison of alternative land use strategies

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The transition from livestock to wildlife-based land use is one increasingly common response to widespread degradation in dryland ecosystems. This shift is one of the major forces driving landscape change with direct consequences for ecosystem health and human welfare. However, the consequences of promoting animal compositions with more mixed feeding regimes and higher browser proportions for savannah vegetation and soil condition remain so far largely unclear.

In this study, we aimed to assess the impact of the transition from traditional cattle-dominated land use to wildlife-based strategies on selected ecosystem properties with regards to vegetation and water processes. We used the ecohydrological, spatially explicit savanna model EcoHyD and refined an existing herbivory algorithm to assess the long-term impacts of various herbivore-related land use strategies on a Namibian rangeland. We varied the densities of grazing and browsing herbivores as well as mixed-feeders, allowed for a certain flexibility in their diet and determined the resulting impact on the three major plant groups (shrubs, perennial and annual grasses).

Overall, we could reproduce the well-known shrub encroachment phenomena with a loss of the perennial grass matrix under high stocking rates of cattle. As a result, animals had to feed on annual grasses and could partly not meet their feeding demand. We also found that the grass matrix performed better under moderate and low feeding pressure from mixed feeders in terms of higher perennial cover. Perennial cover generally withstood browsing pressure well. A novel and unexpected result was that we did not find degradation patterns in browser-dominated communities regardless of the density of animals. This increased grass cover also led to a higher water uptake by plants, since less water was lost by evaporation and runoff.

We conclude that the transition to land use strategies with high browser proportions, even in high densities, prevents ecosystem degradation. It maintains healthy vegetation with high cover of perennial grasses over a long period of time, which also means lower erosion risk and higher provision of ecosystem services.

16-O-04 - Improving estimation of woody aboveground biomass in drylands by accounting for disturbance effects

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Almost one third of global drylands are open forests and savannas, typically shaped by frequent disturbances such as wildfire, herbivory, and woodcutting. Global environmental change may alter typical disturbance regimes and increase pressure on vegetation, thereby often reducing woody aboveground biomass (AGB) and carbon storage. To better understand these current and future transitions in these drylands studies need to rely on robust estimations of AGB. However, most AGB estimation methods have been developed for undisturbed forest ecosystems and their application in disturbance-prone dryland ecosystems leads to unreliable or even biased AGB estimates. Moreover, these methods cannot quantify AGB losses caused by different disturbance agents. Here we propose a novel methodology to estimate individual- and stand-level woody AGB in disturbance-prone ecosystems. It also comprises a detailed damage assessment, harnessing the ecological archive of trees for past disturbances.
Based on large inventories collected along steep gradients of elephant disturbances in an African dryland, we compared the AGB estimates generated with our proposed method against estimates from a conventional method. We compared the methods' results on individual and stand level and further explored advantages of our proposed method with regard to disturbance impact quantification. Results indicate that the conventional method systematically overestimated individual AGB due to the lack of a damage assessment but underestimated stand-level AGB (> 90 % in highly disturbed savannas) due to omission of small and irregular growing individuals. Estimation bias was particularly high when stand-level AGB was low and disturbance impacts were severe.
Our proposed method more accurately quantifies woody AGB in disturbed ecosystems, as well as AGB losses attributable to various disturbance agents. It therefore helps to better quantify impacts of land-use change on ecosystem services and functions in drylands.

16-O-05 - Timing in fieldwork on Namib fairy circles matters: grass dieback in circles happens immediately after rainfall

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The fairy circles (FCs) of the Namib Desert are one of nature's greatest mysteries. Millions of these barren patches extend over vast areas along the eastern Namib where rainfall is highly stochastic, both spatially and temporally. The annual *Stipagrostis* grasses germinate only when sufficient rainfall has fallen at a site. Then, the barren desert transforms within one or two weeks into a green carpet of young grasses. This is also the time when the FCs start to change their appearance. Ring-like stubbles of the perennial belt are suddenly surrounded by a continuous matrix vegetation, new circles may form within the matrix and freshly germinated grasses within the circles may soon start to die. Consequently, the right timing of fieldwork is critical to reveal the underlying processes in the formation and maintenance of the barren FCs.

In this study we followed the first rain events in the Namib during February to April 2020 and 2021. Specifically, we selected in each of the four regions Brandberg, Kamberg, NamibRand Nature Reserve, and Garub several FCs where new grasses were dying inside the circles. We measured the root and shoot lengths of these grasses and compared them to the vital green grasses of the surrounding matrix vegetation. We also drone-mapped the areas repeatedly to detect changes between 2020 and 2021, and between several weeks within a rainy season.

We found that grass dieback within FCs happened immediately after rainfall. In addition, many FCs did not develop any grass cover at all after the rain, even though the surrounding fresh grasses had just germinated and were green and vital. In this talk we will discuss these findings and illustrate them with statistics and photos of the grasses.

16-O-06 - Studying transitions in ecological systems by applying an integrated social-ecological framework

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Sudden regime shifts pose a major threat to various ecosystems and people's livelihoods worldwide. Research on regime shifts and tipping point phenomena has led to an improved understanding of their dynamics. However, their crossing is still hard to predict and therefore tipping points appear as unpleasant surprises with dramatic consequences. To identify early warning indicators, we still need a more profound understanding of tipping point dynamics. For this, it is necessary to take a systemic, integrated view that considers both ecological and social perspectives. Previous study approaches have often been simplified in this regard, while the gap of tipping point studies in social-ecological systems remains. Here, we present an integrated research framework to study ecological tipping points in a social-ecological context. The framework comprises the characterization of an ecological tipping point and the mechanistic understanding of its social and ecological drivers. In particular, we focus on interactions and feedbacks within social-ecological systems by applying equally weighed study approaches in both sub systems. To address the need for long-term analyses, our proposed framework is threefold, consisting of a retrospective, a comparative and a prospective approach. For each approach, several interdisciplinary studies in both sub systems are implemented on multiple scales. This includes the integration of local knowledge and the development of dynamic models. As a practical example, we present NamTip, a transdisciplinary research project that focusses on understanding and managing desertification tipping points in Namibia's drylands. The project realizes the threefold framework by implementing, e.g., analyses of time-series and archival data, experimental and observational studies, as well as scenario development and exploration of decision-making with local farmers. In general, the proposed integrated research framework promotes a holistic understanding and a balanced perspective on tipping points in social-ecological systems while preventing the oversimplification of one subsystem.

16-O-07 - Drought length matters for vegetation resistance and resilience in a South African savanna grassland

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Droughts of various intensity and length regularly affect dryland ecosystems and this will likely even increase in the future. Yet, the demand for ecosystem services delivered by dryland rangelands – mainly forage for livestock – is growing. Both the effects of drought duration, and the potentially interactive effects of drought and grazing are still not fully understood. We thus asked: (1) How resistant is herbaceous vegetation to a two- and a six-year extreme drought? (2) How does vegetation recover after an extreme drought of two or six years? (3) Which role does grazing play for drought resistance and resilience?
We used data from the large-scale field experiment "DroughtAct", located in a semi-arid savanna in Limpopo province, South Africa. The experiment comprises treatments of moderate grazing vs. resting, and drought vs. ambient rainfall. Drought was simulated using passive rainout-shelters reducing ambient rainfall by 66 % for two and six years. Annual data on aboveground net primary production (ANPP) and plant community composition were collected. All "DroughtAct"-treatments were also simulated using vegetation modeling (aDGVM2). We found that the two-year drought had minor effects on ANPP. An improved rain-use efficiency initially buffered drought effects, and vegetation recovered rapidly. In contrast, the six-year drought strongly reduced ANPP and altered species composition. While grazing improved the recovery potential after the short-term drought, it accelerated the destructive effects of long-term drought. While the model showed a stronger initial drought response already in the second year, the results were generally similar and predicted a lengthy recovery period particularly after the six-year drought. Our results underline the importance of drought length for ecosystem resistance and resilience. Management strategies need to be adapted to account for future, more prolonged drought and to prevent vegetation transitions to a desertified state.

16-O-08 - What characterizes winner and loser species? Effects of severe drought and grazing on dryland grassland

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Severe drought may trigger a transition of vegetation composition in dryland grasslands, with productive perennial grasses often being replaced by annual grasses. Grazing pressure is thought to exacerbate drought effects, but little is known on the joint effects of grazing and drought on the functional and taxonomic composition of the herbaceous vegetation in African savannas. This study thus aimed to elucidate which herbaceous species and plant functional types (PFTs) are most resistant to prolonged drought and grazing, and whether resting plays a role in this context. Thus, we performed a six-year field experiment in South Africa's Limpopo province, combining drought and grazing treatments.
Aboveground herbaceous biomass was harvested annually and separated into species. We grouped species into five PFTs, i.e. very broad-leaved perennial grasses, broad-leaved perennial grasses, narrow-leaved perennial grasses, annual grasses, and forbs. For all species, we also recorded three leaf traits (leaf area - LA, specific leaf area – SLA, and leaf dry matter content – LDM) to describe their resource acquisition strategies. We used generalized linear models to test for treatment effects and their interaction. Association indices were used to detect the relationship between species and treatments. We found that there were no absolute winner species or PFTs, as the six-year severe drought had a pronounced negative impact on the biomass production of all species and PFTs. However, we detected relative winners with increases in relative abundances, mainly forbs and less palatable narrow-leafed grasses with comparatively low LA and high LDMC such as *Aristida stipidata* Hack. These species and PFTs also tended to be favored by grazing. Although few species profited from resting, the combination of drought and resting proofed to be particularly unfavorable for most species. Winners and losers can indicate ecological transition and may be used to guide management decisions.

16-O-10 - Climate-grazing interactions in Mongolian rangeland vegetation

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Mongolia hosts one of the biggest still largely intact dry rangeland ecosystems in the world, but climate and land-use change are threatening the resilience of these ecosystems. Predicting the responses of vegetation to grazing under climate change is crucial to sustain ecosystem functioning and therefore provisioning of the ecosystem services in the future. However, such predictions require a sound understanding of the interacting effects of grazing and climate on key facets of the vegetation. We studied rangeland vegetation on 15 local grazing gradients along a 600 km long climate gradient in Mongolia, with 100 mm mean annual precipitation in the south and 250 mm in the north. Data on species diversity, plant community composition and biomass were collected and analyzed via a range of univariate and multivariate methods. The overall aim of the study was to improve our understanding of the ecosystem functioning of Mongolia's rangelands, and to use our gained insights to predict possible consequences of future changes. We found large differences of the effects of grazing on the studied vegetation properties between the dry rangelands with high climatic variability in the south, and the moister rangelands with lower climatic variability in the north. Our results suggest that dry rangelands are mainly controlled by environmental constrains, which affect both the vegetation and the livestock. With increasing resource availability and decreasing climatic variability, biotic interactions become more important. Available studies suggest that precipitation, temperature and climatic variability increases in the future. Against this backdrop, our study implies that regions with already high climatic variability are more resilient towards future changes, whereas climatically more stable and moister regions are threatened by future climates. A recently published rangeland production model, which was based on our biomass data, supported these conclusions.

16-O-11 - The invasive *Opuntia ficus-indica* homogenizes native plant species compositions in the highlands of Eritrea

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Invasion by exotic species is recognized as one of the major threats to biodiversity. The effects of invasion by *Opuntia ficus-indica* (Cactaceae) on the species diversity, richness and composition of invaded dry shrub land communities were studied at three sites in the highlands of Eritrea, East Africa. Investigations were made whether the presence of *O. ficus-indica* causes a negative effect on the native biodiversity in a region rarely studied so far. The vegetation in invaded and uninvaded plots with similar habitat conditions was sampled and differences in the species composition, diversity and richness were compared between the plots. The overall plant species composition differed significantly with invasion by *O. ficus-indica*. The invasion by *O. ficus-indica* also led to a significant homogenization of community compositions. The species richness and Shannon diversity index did not differ significantly between the invaded and uninvaded plots. Nevertheless, we still detected species with significantly lower occurrence in the invaded plots (*Psiadia punctulata*), but also species which preferred invaded plots (*Plectranthus hadiensis*). We conclude that *O. ficus-indica* exerts a negligible effect on the species diversity and richness but that it affects species composition and that there are species which suffer due to its presence. Due to the continuous pressure of the invasion by *O. ficus-indica* on the species composition and dry climates, further homogenization in the native species diversity is to be expected in the future for the highlands of Eritrea.

16-P-01 - Utilizing perennial grass species' population patterns to detect looming desertification tipping points in semi-arid regions

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Namibia is one of the global dryland regions facing desertification threats due to overgrazing and recurrent drought. This has disastrous effects on forage provision and consequently on local livelihoods. Unfortunately, the mechanisms underlying sudden shifts of rangeland ecosystems towards a desertified state are still poorly understood. The ability to predict desertification tipping points with the aid of suitable ecological indicators is critical to ensure sustainable management of rangeland resources, which are a backbone of rural livelihood in drylands worldwide. Accordingly, we aimed to identify key perennial grass species that can be used as early-warning indicators for desertification tipping points; and to assess their dynamics and response to grazing pressure. The study was conducted in the eastern region (Otjozondjupa) of Namibia where 4 communal areas and 4 freehold farms (commercial) were selected in order to compare perennial grass population responses within differently management land-use systems. A space-for-time approach was used for this purpose, where plots were laid out along local grazing gradients. Data on species occurrence, size structure and recruitment were collected. Preliminary findings show that a sudden decrease or disappearance of some sensitive native perennial grass species along grazing gradients and lack of seedling recruitment could be a useful hint to an approaching desertification tipping point.

16-P-02 - Africa's woodlands in transition: Effects of climate change, land-use change and diversity on their carbon pools

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Globally, forest and savanna ecosystems are among those containing the main carbon pools. Woody biomass within Africa's ecosystem stores about 25 % of tropical forest carbon. However, African forest and savanna ecosystems are currently experiencing rapid transitions due to deforestation and land-use intensification, with profound, usually negative consequences for carbon storage in woody biomass. At the same time, ongoing climate change is projected to have substantial effects on carbon pools, which potentially interact with the effect of land-use change. Moreover, climate and land-use change are known to be the most important drivers for biodiversity losses, which can in turn have indirect effects on carbon stocks. There is the need for a better understanding of how climate and land-use change jointly and directly affect carbon pools in Africa's woody vegetation. Likewise, we need to better understand the extent they exert indirect effects on carbon storage through their effects on plant diversity.
We will conduct a field study along a latitudinal climatic gradient in West Africa, from arid Sahel to tropical Guinean climate zone. Along this climatic gradient, six study sites will be located where we will capture local gradients of land-use intensity, spanning from protected areas over rangelands to intensively used agricultural fields. In this way, we can use a crossed space-for-time substitution for climate and land-use change, which will allow us to disentangle potentially interactive effects of these two global change drivers on carbon storage in woody vegetation. Aboveground and belowground biomass and carbon pools of woody vegetation will be quantified via novel methodology designed for disturbance-prone ecosystems. Woody species' plant functional traits in the global spectrum of plant form and function will be recorded to assess indirect effects of climate and land-use change on carbon stocks via their imprint on functional vegetation composition and diversity.

SESSION 17

Special Session: GfÖ Research Funding on Decline of Insect Abundance

CHAIR: ***Thomas Frank***

To point to the ongoing and tremendous decline of insects, the Ecological Society of Germany, Austria and Switzerland (GfÖ) announced a call for research proposals on "Decline of Insect Abundance" in 2019. Five of the submitted applications were granted. The granted proposals cover the following topics: 1. Trends of ground beetle numbers over 33 years in the Kaiserstuhl 2. The importance of dead wood amount for preserving insect diversity in naturally disturbed forests 3. Ecosystem effects of reduced insect abundance 4. Tits as monitors of insect abundance and diversity 5. Insect enhancement in lowland streams. In this special session the granted proposals will be appropriately dignified. The session will consist of talks given by the awardees on the aforementioned topics. It gives the audience the opportunity to inform themselves about current projects dealing with insect decline.

17-O-01 - The importance of dead wood amount for preserving insect diversity in naturally disturbed forests

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Natural disturbances such as insect outbreaks, wildfires and storm damage affect forests all over the world with increasing frequency. Treatment of disturbed sites often involves the extraction of all damaged timber, so-called salvage logging. Justifications for this procedure are multifaceted and include fuel reduction, pest control, and mitigation of economic losses. However, the complete removal of deadwood can have negative effects on insect species. Disturbed forests have high structural heterogeneity and thus provide habitat for numerous species, especially insects. Here, we aim on developing management strategies for storm-damaged forest sites that support conservation of insect diversity and simultaneously consider economic concerns. We analyse the effect of dead wood amount on abundance, diversity and community composition of different groups of insects in a storm-damaged beech forest. We additionally investigate the role of other site factors such as canopy openness, temperature and humidity, and plant cover. We show that, during the first two years, disturbed sites host significantly more species and individuals of saproxylic beetles, aculeate Hymenoptera, and Heteroptera than undamaged, managed forest serving as control. Our findings also show that the extraction of the most valuable timber only, with the retention of small-diameter branches, does not negatively influence insect abundance and richness. We conclude that, not dead wood amount alone, but rather an equilibrium of canopy openness, insolation and some available dead wood provides the best conditions to support a maximum number of species. Sustainable management of windthrow-sites should therefore include the partial retention of dead wood to create structures that are favourable for biodiversity conservation.

17-O-02 - Diversity of Insects in Nature protected Areas (DINA) – insect decline from a scientific and societal perspective

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Due to their crucial functional role as pollinators, destruents, predators, and prey, insects are of central importance for healthy ecosystems and a key to all efforts to maintain biodiversity and preserve essential ecosystem services. Insects represent the major component of animal diversity in land ecosystems and affect nearly all food webs and biocoenoses. Insect declines and biodiversity loss have attracted much attention in recent years, but lack of comprehensive data, conflicting interests among stakeholders and insufficient policy guidance hinder progress in preserving biodiversity.

The joint project DINA with its eight research institutions investigates insect diversity in 21 nature protected areas throughout Germany. As a unique feature transects of malaise traps are established at every location. These transects of five traps stretch from arable land into the adjacent nature reserve. Data of insects, vegetation and soil are acquired by a network of citizen scientists and subsequently analysed by the project partners.

As a pioneering research project in this field, civil society was actively involved from the very beginning and includes a transdisciplinary dialogue with relevant stakeholders (local authorities, policymakers, and farmers). To this end, public events on the topic of insect loss are taking place at three of the 21 locations. This combination of a scientific and societal perspective will support the development of firm policy recommendations to improve legal frameworks, landscape planning, land use, and conservation strategies.

17-O-03 - Tits as monitors of insect biodiversity

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The advances of land use changes and insect declines in Germany affect insectivorous bird populations particularly during the breeding season. In this time, most passerine birds depend on insects and other arthropods as food resource for their nestlings. Previous studies indicated lower prey availability in urban than in forest sites leads to lower breeding success. In forests, the two sympatric species Blue and Great Tit showed interspecific competition due to similar diet preferences, while in other habitats still little is known about nestling diet and prey preferences. In our research, we investigated if nestling diet composition of Blue and Great Tits (Paridae) varied among species and different habitats (forest, extensively managed orchards, and urban parks) using faecal metabarcoding and next generation sequencing. In addition, we examined the arboreal arthropod communities among the habitats through DNA barcoding and compared them with the nestling diet composition to identify parental prey selection. Overall, we detected a diverse diet range of arthropod species across eight orders in the nestling diet of both tits. Lepidoptera dominated the nestling diet composition in all habitats. Grouped by family level, diet composition and prey selectivity were broadly similar with minor differences among habitats and species. Both tit species showed selectivity for only a few insect families across all habitats (mainly Lepidoptera and Hymenoptera). Metabarcoding of tit faeces seems a promising method to monitor preferred prey insects such as Lepidoptera, and our study may provide a baseline to monitor population changes in these insects.

17-O-04 - Drifting pesticides impact butterfly diversity and abundance in a mosaic landscape

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The use of pesticides has increased significantly over the past decades due to agricultural intensification. As shown in numerous studies, pesticides negatively affect the functioning of ecosystems and increase species mortality. Most existing studies compared areas treated and not treated with pesticides, neglecting that pesticides act across-boundary. However, in landscapes with a mosaic of land-use, all areas are assumed to be affected by pesticides, even those not been treated. To test for such negative edge effects from drifting pesticides on biodiversity, we analysed the diversity and community structure of butterflies across such a mosaic landscape, composed of olive and hazelnut plantations, meadows, fallow land, hedgerows and forest edges. For organic olive plantations, we distinguished plots adjoining other organic farmland or adjacent to sites treated with pesticides; all other studied habitats are surrounded by other organic farmland. We counted butterflies along line transects, and recorded habitat parameters for each transect. In our analyses, we considered management intensity, surrounding landscape and pesticide applications in adjoining areas. Community structures differed considerably among the habitat types. Hedges and forest structures showed a significant effect on abundance because habitat parameters such as the degree of shading impacts butterfly diversity and abundance. Butterfly species richness was highest on fallow land and lowest on olive plantations. Butterfly abundances was strongly depending on the impact of pesticide use, and the organic olive plantations adjacent to agricultural fields treated by pesticides was only half of that of such plantations not in close contact to pesticide applications. Consequently, our study underlines that pesticides significantly impact biodiversity, also beyond the fields where they were applied. Thus, the intermixing of conventional and organic farming has to be seen as problematic.

17-O-05 - Negative effects of the fungicide Amistar on bumblebees are resource-dependent

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Declines in bee diversity and distribution are ascribed to a combination of various stressors, including pesticides and lack of resources. And, even though nutrition was shown to affect the resilience of bees to pesticides, pesticide effects are typically assumed to be consistent between crops and the regulatory risk assessment of plant protection products disregards interactions with nutrient limitation. Fungicides are often thought to be harmless to bees. However, bees are not only frequently exposed to fungicides but both experimental and observational evidence indicates detrimental fungicide effects on bees.
Here, we assess the interaction between one of the globally best-selling fungicides, Amistar (active ingredient: azoxystrobin) and resource quality and diversity, on *Bombus terrestris* colonies in a full factorial semi-field experiment. The bumblebee colonies were confined in (a total of 39) large flight cages with untreated or Amistar-treated purple tansy, buckwheat, or a floral mix. We hypothesized that the higher diversity of the floral mix and the higher pollen protein content of purple tansy compared to buckwheat would promote the development and resilience to the fungicide of the bumblebee colonies.
Preliminary results show that colonies in buckwheat cages developed, indeed, less well. Moreover, Amistar exposure through purple tansy increased adult mortality, reduced colony growth, and limited worker body size. However, these effects were not found in buckwheat or the floral mix. This shows that the effects of the fungicide Amistar are resource-dependent.

17-O-06 - Aboveground impacts of a belowground invader: how invasive earthworms alter aboveground arthropod communities in a northern North American forest

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Declining arthropod communities have recently gained a lot of attention with land use and habitat loss among the most-commonly discussed drivers. Here, we focus on an underrepresented driver of arthropod community decline: biological invasions. For ~12,000 years, earthworms have been absent from wide parts of northern North America, but they have been re-introduced with dramatic consequences. Most studies investigating the impacts of this invasion naturally focus on the belowground world with only few studies looking at how aboveground communities might change. We present observational data from a Canadian forest sampled in 2019 to assess the response of aboveground (vegetation- and ground-associated) invertebrate communities to earthworm invasion. We sampled earthworm and aboveground arthropod communities in 60 plots (1x1 m), split into three areas with increasing invasion status (low, medium, high). We focused our analysis on arthropod macrofauna, which resulted in a total count of ~13,000 individuals, dominated by Hemiptera, Diptera, Araneae, Thysanoptera, and Hymenoptera. Total arthropod abundance, biomass, and species richness declined significantly from low to high invasion status areas with reductions of 61, 27, and 18 %, respectively. Additionally, we observed a significant decrease of arthropod abundance with increasing invasive earthworm biomass. While predator abundance (dominated by Linyphiid spiders) did not change, herbivore abundance (dominated by Cicadellidae, Hemiptera) declined by 71% from low to high invasion status areas. Our results illustrate how earthworm invasion alters aboveground arthropod communities in northern North American forests and show that belowground invasions might be an underappreciated driver of aboveground arthropod decline.

17-O-07 - Recent developments in aquatic insect diversity in Switzerland

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In recent years, massive declines in insect biodiversity have been reported from many European countries. However, regional, taxa- and ecosystem-specific differences have also been shown. In Switzerland, limited knowledge about the current state of the entomofauna exists.
Here, we analysed nationwide, systematic monitoring data on aquatic insect diversity collected at 438 sites in Switzerland from 2010 to 2019. In addition to taxonomic richness, we also considered functional traits such as temperature preferences and feeding guilds. Furthermore, we explored the sensitivity of aquatic insects towards pesticides. We found that in general, insect species richness increased in the time period considered. Warm-adapted species showed the strongest increase with time while cold-adapted species richness remained stable. With respect to functional feedings guilds, generalists such as collector-gatherers displayed the highest gain in species richness, and pesticide-insensitive taxa increased most with time. Moreover, we developed a predictive model of aquatic insect richness by considering both in-stream conditions such as temperature and catchment-level factors such as land use and found that the importance of predictors depended on the functional group under consideration.
Our results suggest that recent developments in insect species richness are context-dependent and affect functional groups differently. As our data only covers 10 years of monitoring, longer investigations are needed to confirm the positive trend and to reveal if the increase in temperature and pesticide tolerant species could lead to a decrease in specialised species and a homogenisation of biotic communities in the long term.

17-O-08 - The effect of climate warming on bumblebee diversity and community composition along the elevation gradient of the Kalsbach-Valley in East Tyrol: a historical comparison

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Climate change has been commonly observed as a main driver for changes in diversity, community composition and spatial distribution of several species. Mountain ecosystems including alpine bumblebees are of particular concern. In this study we surveyed bumblebee species in the Kalsbach-Valley in Austria and compared our findings to records from the 1930s to investigate changes in community composition at three altitudinal levels (1100-1499 m, 1900-2399 m and 2400-2799 m). Further, we explored the distribution of functional traits of bumblebees and related our findings to climate warming through the calculation of a Community Temperature Index (CTI). Our results showed a significant decrease in diversity of bumblebee species at lower altitudes (1100-1499 m), particularly through less parasitic species, while sub-alpine and alpine elevations showed no explicit trends. Differences in bumblebee community compositions were strongest determined by altitudinal levels but further showed a significant effect though increasing spring temperatures between recent and historic samples. These findings were confirmed by the prevalence of functional traits and CTI calculations, exhibiting a significant species turnover towards warm-adapted bumblebees at 1100-1499 m related to higher proportion of lowland and generalistic species at different elevation levels. We conclude that bumblebee community compositions in the study area were significantly affected by climate warming, although CTI's visualization of recurrent bumblebee fauna still lacked behind local climate projections. While strong decreases in species diversity at lower altitudes might further indicate effects of climate warming, land-use change and seasonal abundance shifts remain as other presumable explanations. To maintain stable bumblebee populations and resilient ecosystems, specific conservation actions are necessary to protect climatically suitable and high-quality habitats.

17-O-09 - Effects of climatic changes on butterflies and hostplants along an elevational gradient in the German Alps

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Climate warming forces many species to shift their distributional ranges polewards or uphill in order to track their climatic niche. However, few studies have addressed community-level responses of insects to climate change across elevational gradients and the direct and indirect drivers behind. Here, we repeated a butterfly monitoring from 2009 on 33 grassland sites along five elevational transects in the National Park Berchtesgaden (Germany). We sampled adult butterflies from May until September and recorded the diversity and abundance of potential host plants. We examined changes in butterfly species richness, abundances, species and trait compositions and quantified changes in the elevational distributions of butterflies and hostplants over time. We further disentangled, to which amount changes in butterfly richness are related to either temperature shifts, host plant community shifts, or management.

17-O-10 - Ground-nesting bee survival after soil disturbance

***Anne-Christine Mupepele*[1]**

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Around half of German's wild bees spend most of their life time below ground. For successful conservation of ground-nesting bees in an agricultural context, we aim at understanding the impacts of soil disturbance on the survival rate of ground-nesting bees. We translocated soil cubes with nests during winter before bee emergences. Translocated soil cubes were either heavily or moderately disturbed to mimic ploughing or excavation of soil. With our experiment, we investigate the impact of translocation and soil disturbance on the common ground-nesting bee *Colletes cunicularius*. Using emergence traps, we quantify the number of bees emerging and compare moderate to heavily disturbed translocated soil, and in comparison, to the non-translocated control sites. In a larger bee cage, we further investigate whether translocated bees establish nests at a new location and under artificial conditions with a limited flight range. With this we aim to assess the impact of agricultural disturbance, the potential of translocating bee populations and the possibility of establishing a new solitary bee species for further research on this understudied group.

SESSION 18

Remote Sensing of Ecosystem Functions, Processes and Services

CHAIRS: ***André Große-Stoltenberg, Stefan Erasmi***

Remote sensing data have proven their benefit in a wide range of applications in ecological and ecosystem research. Applications encompass various ecosystems from urban, marine, and freshwater to agriculture, forest and other vegetated land. Most applications built on the concept of key indicators (e.g. spatial, spectral and temporal metrics) that can be assessed from remote sensing analysis to describe the condition of and pressures on ecosystem functions, processes and services. Based on this concept, remote sensing is a valuable tool to indirectly monitor various aspects of ecosystem properties and their changes at different spatial and temporal scales. The session aims at highlighting the overall concept of remote sensing, based ecosystem indicators and to give an insight into recent trends and developments of algorithms, sensors and applications in this field. We welcome contributions from methodological to applied research with the following (non-exclusive) topics: - Monitoring of indicators for condition and pressures of ecosystems - Predicting ecosystem services from remote sensing data - Advanced machine learning techniques for remote sensing data analysis - Developments in remote sensing sensors and platforms for mapping ecosystem properties.

18-O-01 - Developing a spatially explicit, nation-wide habitat map with remote sensing: Challenges, data and methods

Bronwyn Price[1], Nica Huber[1], Robert Pazur[1], Marius Rüetschi[1], Christian Ginzler[1]

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Mapping the distribution of habitats is vital for successful management and monitoring of biodiversity. Within Switzerland, there is strong demand for a spatially explicit, area-wide habitat map to inform field surveys, provide base data for research and ecological infrastructure projects. The stakeholder group is broad including scientific researchers, government agencies, environmental advocacy groups. It is important for the habitat map to reflect not the potential distribution of habitats but the current distribution taking into account landscape management. Therefore, we take advantage of Earth Observation data, in particular high temporal resolution Sentinel-1 and -2 satellite imagery and digital aerial photography and high-resolution 3D information derived from it. We map habitats to the second level of the Delarze, Gonseth et al. (2015) classification, which is the most widely used in Switzerland. Within the software eCognition, airborne ortho imagery (1m resolution) was segmented into 'image primitives' based on reflectance in the RGB and NIR bands, and vegetation indices. We then brought together information from habitat distribution models, landscape models and land use maps to assign habitat types to these segments in a rule-based approach. The habitat distribution models used in the assignment procedure were developed via machine learning approaches trained with field data from large scale Swiss vegetation monitoring programmes, and spatially explicit, area-wide predictors derived from Earth Observation data from the Sentinel-1 and -2 constellations, climate, topography, and soil data. We undertook stakeholder consultation and workshops to ensure that the habitat map was developed to meet stakeholder needs and will be fit for purpose for the wide variety of end-users. The approach has been developed to be semi-automated so that it can be re-applied with updates of the base data at specified time intervals, enabling use for monitoring purposes.

18-O-02 - Modelling vegetation dynamics from Satellite time series to estimate proglacial primary succession in the course of global warming - a case study in the Eastern Italian Alps

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As a result of climate warming, glacier retreat opens new areas for colonisation of plants in the alpine and nival zone. Reconstruction of the vegetation in the proglacial area with high temporal and spatial resolution improves the understanding of the pace of ecological changes and the enlargement of the proglacial area.
This study used in-situ observations from 2019 and 2020 in the glacier forelands of Fürkele-, Zufall-, and Lnagenferner (Ortles-Cevedale group/Eastern Italian Alps, 2281 m a.s.l. to 3757 m a.s.l.) in combination with vegetation indices (*VI*) from Landsat scenes. The suitability of four *VI* for an area-wide reconstruction of vegetation cover was tested, applying a Bayesian beta regression (RStan). As the model evaluation showed the best fitting for the Normalized Difference Vegetation Index (*NDVI*), we used the *NDVI* for calculating the total vegetation cover for the years 2019, 2011, 1997, and 1986. The development of the proglacial area was analysed using a digital elevation model based on Airborne Laser Scanning data, orthophotos and aerial images, historical maps and field mapping campaigns. In-situ vegetation data were collected for 65 plots in the glacier forelands to determine the successional stages. The area of total vegetation cover showed an increase from 0.25 km² (1986) to 0.90 km² (2019), with significantly different mean annual changes in vegetation cover for the studied years. The increase in vegetation cover corresponded to the rising mean temperature of the period June-July-August from 4.5 °C to 8.6°C between 1986 and 2019. Our results show that the *NDVI* in combination with in-situ observations is a suitable tool for monitoring vegetation cover in glacier forelands to observe ecological responses to climate change and glacier retreat in the long term.

18-O-03 - Tracking the temporal dynamics of insect defoliation by high-resolution radar satellite data

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Quantifying the loss of leaves by insects on large scales is a major challenge in forest management. Such assessment of ecosystem disturbance and herbivory resistance is urgently needed for the evaluation of ecosystem functions. However, the trajectory from leaf-flush to insects' defoliation to refoliation is highly variable and, thus, difficult to track, particularly in fragmented deciduous forests of Central Europe. We use a field experiment on one of the most global pests, gypsy moth *Lymantria dispar*, in mixed-oak forests to test how well satellite-borne radar data (Sentinel-1) can track the fine-scale temporal trajectory of canopy defoliation. We developed a canopy development index (CDI) and a normalized CDI (NCDI) by calculating the difference in backscatter intensity between two polarizations from radar data of the growing season. They were validated by optical (Sentinel-2) and terrestrial laser scanning (TLS) data as well by intensive caterpillar sampling from canopy fogging. The CDI and NCDI from radar data are highly correlated with optical and TLS data (Spearman's ρ=0.79 and 0.84, respectively). The $\Delta NCDI_{\text{Total herbivory period}}$ as a proxy of defoliation severity index from CDI time-series significantly explains the abundance of caterpillars (R^2 = 0.52). The four indices as proxies of defoliation severity and refoliation indices classify partially a priori forest types of defoliation risk levels and insecticide treatment and almost perfectly a posteriori forest types between heavy or lightly defoliation. Sentinel-1 radar data with high spatial and temporal resolution and cloud independence potentially open a new opportunity to measure highly dynamic canopy herbivory with sufficient grain and unlimited spatial extent.

18-O-04 - Mapping ecosystem degradation in Iranian semi-steppe rangelands using remote sensing

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Multiple natural and anthropogenic stressors effect ecosystem functioning and services in dryland ecosystems such as Iranian semi-steppe rangelands. These stressors include altered precipitation and drought regimes as well as Land Cover/Land Use changes and can cause ecosystem degradation. Mapping the status of rangelands is traditionally conducted via field assessment. However, it is not well understood yet how to scale up these field assessments to landscape scale using remote sensing as a basis for a continuous monitoring and sustainable management. Here, we first classified the study at watershed scale as healthy, at-risk, or unhealthy using ecosystem function indices including soil and site stability, hydrologic function, and integrity of the biotic community based on a common rangeland health field protocol. Then, remote sensing metrics were computed including several landscape metrics, the moving standard deviation index, and the leakiness index. Multivariate analysis was then used to assign each site with a health class. Results show that regions with high levels of ecosystem health are distributed mainly near the center and western part of the study area where sites had lower amounts of spectral heterogeneity, number of patches, edge density, and resource leakage. In the southern part, several sites with low levels of ecosystem health are identified because of the higher amount of soil surface loss, plant mortality, soil compaction layer, and invasive species. We found a high agreement between the health clusters based on field and remote sensing data when using a combined approach of DBSCAN and K-means clustering together with NMDS (correlation of the Procrustes rotation of 0.88). Thus, methods of remote sensing combined with multivariate statistics have high potential to map ecosystem degradation in drylands if carefully combined with standard field assessments.

18-O-05 - Assessing agricultural land fragmentation in Central Asia using Landsat time series data

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Fragmentation of agricultural land is a common phenomenon in Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan), but has not been evaluated thoroughly using remote sensing data at large scale, yet. This talk will cover the current research activities regarding remote sensing and agricultural land use trends in the frame of the junior research group TRANSECT (https://www.transect.de/). To assess agricultural land-use fragmentation, we derived three different texture measures (entropy, variance, and homogeneity) from yearly aggregated NDVI data using the Google Earth Engine. A simple change detection analysis was implemented, to derive temporal windows of the transformation from large collective farms (*sovkhoz* and *kolkhoz*) into smaller parcels managed by individual farmers. Our results indicate that the presented approach describes well the transition from large-scale farming systems to smaller enterprises and peasant-based land-use systems in most parts of Central Asia after the collapse of the Soviet Union in 1991. However, the timing of these transitions varied at the local and regional scales and seems partially decoupled from political reforms of the agricultural sector. Our approach offers a novel way of assessing and monitoring land restructuring processes, which often correlate with changes in agrobiodiversity as the latter is typically higher in more fragmented agrarian landscapes. Future research will also explore the potential to describe processes of land consolidation and -concentration using texture time series data.

18-O-06 - Do we have to spend more time in the lab?

***Hannes Feilhauer*[1,2]**

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Regression approaches are a frequently used for the retrieval and mapping of functional leaf traits from spectral reflectance data. However, the sample size for training data in remote sensing studies targeting such functional traits is often determined by availability and in may cases limited to n < 100. Machine learning regression approaches promise to require only a comparatively small sample size for achieving robust model results. Still, systematic tests if such small sample sizes enable robust machine learning models are missing to date. This study hence addresses the question 'How does the training sample size affect the model performance in machine-learning based leaf trait retrieval?'
Based on eleven leaf- and canopy-level reflectance data sets on leaf mass per area (LMA) and Chlorophyll concentrations, effects of a decreasing sample size on trait retrieval accuracy and model robustness are tested. In these tests, the performances of Partial Least Squares (PLSR), Support Vector Machine (SVMR) and Random Forest regression (RFR) are compared. The results show that, regardless of the regression technique employed, models that were trained with n < 150 observations tend to be unstable. Further, parameter optimization does not prevent PLSR and SVMR models calibrated with small sample sizes from being prone to over-fitting. RFR models were more robust in the assessment of performance metrics but likewise benefit from more elaborate training. In times of an increasing availability of Earth observation data and virtually unlimited computational resources, the bottle-neck in functional trait retrieval from spectral data is hence the availability of field data for training and validation. We thus have to indeed spend more time in field and lab and/or exploit freely accessible data archives to take full advantage of the opportunities provided by Earth observation.

18-O-07 - Increasing the transferability of global spatial prediction models

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Global products of land use, soil or biodiversity patterns are increasingly utilized and demanded in environmental research and application. Usually, these products are derived from local field observations and remotely sensed satellite imagery via machine learning models. However, there is an ongoing discussion about the quality of these products, the applicability of global models and their generalization. A major problem is that most models are often hardly transferable beyond the training data, which however is required for global spatial mapping. The recently developed method to assess the area of applicability (AOA) of predictive models enables novel insights into the transferability and allows identifying areas where models cannot be expected to make reliable predictions due to missing knowledge about the environments.

In this contribution, we demonstrate how the concept of the AOA can be used to increase the transferability of prediction models.

We first show the relevance of the AOA for the assessment of global AI models and their predictions. Therefore, we reproduce previously published models of global environmental information and estimate their AOA, hence to map and to quantify the area where we expect that the model cannot reliably predict. We then show how spatial feature selection algorithms can help to avoid overfitting and to increase the generalizability of the models, to better predict at new geographic locations.

The results contribute to a better understanding of spatial predictions and lead to a new modelling workflow to derive models that are able to generalize and hence can be utilized in large-scale analysis.

18-O-08 - Grassland forage provision predicted by hyperspectral reflection readings across climate zones

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Forage provision is one of the most important ecosystem services of grasslands or rangelands, while its quantification is still laborious and costly. Remote sensing technologies, such as hyperspectral readings, gain increasing popularity, since they enable fast and non-destructive estimations of these parameters. However, most of the grassland parameters predicted by hyperspectral readings are either reduced to single chemical properties or to plant species level. This study aims to predict forage quality (metabolizable energy content) and forage quantity (green biomass production) from remotely sensed hyperspectral canopy reflection of grassland communities. Furthermore, we test whether forage quality and quantity measures can be predicted across climate zones.
We took hyperspectral readings with a handheld field spectroradiometer from the canopies of grassland communities in temperate German grasslands and semi-arid West-African savannahs. Plant biomass samples were collected at the same area where the hyperspectral readings were taken. To measure forage quantity, the samples were dried and weighed, while forage quality was measured by in-vitro gas production (Hohenheim gas test) and crude protein measurements. The partial least squares regression and random forest regression method were used to establish linear mixed effect models. Subsequently, we determined the relationship between the reflected spectrum and forage quality or forage quantity variables. The models were developed both for single climate regions and across climate regions to test the respective prediction accuracies.
We expect to predict forage quality and quantity parameters from the hyperspectral reflectance readings of grassland canopies for specific climates. Although, models with the aim to match multiple biomes are rather complex and lack prediction accuracy.
In general, such hyperspectral models offer great potential for forage quality and quantity assessments of grassland vegetation. Nevertheless, model accuracy needs to be improved with larger datasets.

18-O-09 - Can unsupervised learning from hyperspectral imagery advance ecosystem stress monitoring? Case study of a grassland site

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We examined patterns in hyperspectral VNIR imagery of a grassland site from before and after the 2018–2019 Central European drought using simplex volume maximisation (SiVM), an easily interpretable unsupervised learning method. Compared to spectral indices, SiVM analyses full reflectance spectra and achieves earlier stress detection. However, it hasn't been scaled up for use in mixed pixel settings. Our objectives were (1) to examine the application of SiVM for the classification of grassland drought stress at the ecosystem scale and (2) to analyse the contributions of different spectral indices and geophysical measurements to the computed stress signal.
SiVM was used to derive typical extreme spectra (archetypes) from the hyperspectral data. Archetypes were aggregated to obtain a fuzzy drought stress classification. The successful application of SiVM was verified with geophysical measurements and vegetation indices as proxy variables for drought-inhibited vegetation growth. The variables were included in a statistical evaluation of the computed stress metric using correlation coefficients and boosted beta regression. Correlations with growth-related indices were strong (all $|r| > 0.75$, $p < 0.001$). In the interannual stress model, carotenoid-related variables had the highest coefficient values. The importance of a modified photochemical reflectance index (PRI_{512}) demonstrates the value of combining imaging spectrometry and unsupervised learning for the monitoring of vegetation stress. It also showcases the potential of SiVM for the estimation of other ecosystem states or fluxes, e.g. photosynthetic efficiency. Usage of complex algorithms for monitoring should be weighed carefully. Computational resources and time will be saved if simpler solutions serve the purpose well enough. It must also be investigated how the method can be generalised across ecosystems.

18-O-10 - Spectral diversity of tree crowns along an elevational gradient in southern Québec, Canada

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Remotely sensed spectral diversity has recently been proposed as an "easy to measure" surrogate for plant diversity. However, recent studies using spectral diversity metrics show varying predictive power in modeling plant diversity and function, and empirical evidence for a strong relationship is still rare. Here, we use hyperspectral imaging data (Compact Airborne Spectrographic Imager - CASI, and Shortwave Airborne Spectrographic Imager - SASI) from an airborne survey in combination with precisely geo-located field data on dominant trees and their canopies in order to predict tree diversity and functions in a forest in southern Québec, Canada. The hyperspectral data are in a new point-cloud data format that has higher spatial-spectral integrity than the usual raster format. In the field, the dominant crowns of all tree species in each of 65 plots were delineated as ovals. Based on measurements of leaf traits, the mean and dispersion of plot-level functional traits were calculated. In addition, we examined phylogenetic diversity and biomass. We compared several spectral diversity metrics to predict the field-observed taxonomic, functional, and phylogenetic diversity. While we show that most spectral diversity are not very strong predictors of field-observed tree diversity, we also identify spectral variation of individual tree species along topographic gradients. From our results we draw conclusions regarding tree diversity predictions based on airborne hyperspectral data and the spectral diversity concept.

18-P-01 - Neural network-enabled remote sensing of hazard-prone ecosystems

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Many ecosystems around the world are especially prone to natural hazards like extreme weather events and seismic occurrences. Extreme weather events, particularly, are increasing in frequency and severity due to the progression of climate change. Therefore, to study biodiversity and the impact of natural disasters on ecological populations, it is crucial to have computational methods for assessment. Automated remote sensing, enabled by machine learning techniques, has emerged as a key asset in assessing the impact on wildlife and developing pipelines to rescue ecosystems and allocate resources and personnel when necessary. In this work, we propose an approach predicated on a convolutional neural network (CNN) framework, of the AlexNet architecture, to harness drone (UAV) imagery in a multitemporal context to understand changes in environments resultant from natural disasters. The classifier outputs a category representing the prediction of the severity of damage incurred. The CNN we develop serves as a baseline for future work improving efficacy and exploring interpretability, which are equally important in the view of the authors.

18-P-02 - Remote sensing derived surface moisture for the Antarctic dry valleys

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The McMurdo Dry Valleys (MDV) are one of Antarctica's biodiversity hotspots, whose local ecosystem properties are threatened to be altered by climate change. To monitor and predict those developments, spatially continuous high-resolution data on abiotic variables are needed. Surface moisture and Land Surface Temperature (LST) are key drivers for the MDV ecosystem. The spatiotemporal distribution of surface moisture in the MDV depends on terrain, permafrost properties, salinity and the surface energy balance and can be detected in the longer optical wavelengths, such as the short wave and thermal infrared, by remote sensors. The aim of this study is to develop a high-resolution spatiotemporal dataset of surface moisture for the Dry Valleys. We use a recently developed high spatiotemporal resolution LST product at a subdaily temporal and 30 m spatial resolution, together with satellite data, thematic maps of the abovementioned environmental influencing factors and terrain information as potential predictors to generate a time series of 30 m surface moisture for the MDV. The surface moisture observations for calibration and validation stem from automatic weather stations distributed throughout the valleys and iButton surface moisture data measured from 0 to 2 cm depth from 2010-2013 at changing locations throughout the MDV. Machine Learning and spatiotemporal statistical methods are explored for modelling surface moisture based on the potential predictor variables. The MDV-wide surface moisture product will serve as an important dataset towards species distribution modelling and monitoring of habitat characteristics in this area.

18-P-03 - Using remotely-sensed vegetation structure to explain arthropod abundance patterns in grasslands

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Remote sensing (RS) has become a significant option for ecological assessments. Especially in agroecology, RS using satellites and unmanned aerial vehicles (UAV) is increasingly employed to map the status of agroecosystems. Remote-sensing data provide near-real-time parameters potentially augmenting traditional assessments. To explore this potential with regard to agrobiodiversity, we related arthropod abundances to grazing intensity at the field station Relliehausen (University of Göttingen). We used a 2.5 m x 2.5 m grid base over nine paddocks (1 ha each) grazed by cattle (four, three and two per paddock, replicated three times) and sampled for arthropods (suction sampling and colour traps) in 45 grid cells (five in each paddock). Specifically, we were interested in the comparison of explanatory power between parameters derived from long-term, traditionally assessed vegetation structures and parameters from current vegetation structures received from UAV. Using simple linear regression models and neighbourhood analyses, we are able to specify the scale-dependent importance of specific vegetation structures, including heterogeneity and stability, for different arthropod taxa.

18-P-04 - How landscape characteristics in a heterogeneous oil palm plantation relate to pest occurrence: a case study from Mapiripán, Colombia

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Oil palm plantations are industrial agricultural landscapes. Such landscapes can be homogeneous and oversimplifying biodiversity. Yet, oil palm plantation design implementing land sharing and land sparing approaches simultaneously can support biodiversity conservation. Biodiversity can thus offer pest control ecosystem service to agricultural systems. However, so far it remains unclear whether landscape structure can be related to pest occurrences. The paper poses two key questions, which landscape structural properties characterize the landscape of the oil palm plantation? How are these landscape structural properties related to the occurrence of the butterfly larvae split-banded owlet (*Opsiphanes cassina*) and the red weevil *(Rhynchophorus palmarum)*? We address these questions through a case study of an oil palm plantation in Colombia. First, the land cover map of the oil palm plantation was digitalized, conforming to the Corine Land Cover nomenclature for Colombia. The land cover map of the oil palm plantation (2009) was updated by visual interpretation to match the state of 2019. Second, we performed a landscape analysis using multivariate cluster analysis to derive nine landscape structural types. The landscape structural types emphasize the landscape characteristics of the oil palm plantation. Third, we performed an NMDS ordination to show similarities among the landscape structural types, land cover, and pest occurrence. Our results show that the oil palm plantation is a heterogeneous agricultural landscape with high landscape connectivity, low landscape fragmentation. The presence of the species (*O. cassina* and *R. palmarum*) relates significantly ($p < 0.001$) to gallery and riparian forests, mixed forests, oil palm plantations, open space and secondary and transition vegetation. The number of individuals of *O. cassina* is significantly different in 2018 (median) compared to 2016 (median) and 2017 (median). Therefore, it is possible to argue the plantation has high landscape diversity that can host different species, some of which can control agricultural pests. Our results illustrate that homogeneous landscape types relate to an abundance of pests. This supports the argument that natural vegetation (e.g. gallery and riparian forests) and heterogeneous agricultural matrix provide biotic entities that regulate pest populations.

18-P-05 - Drones for biomonitoring

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On the Earth Summit in 1992, the United Nations agreed in the Convention on Biological Diversity (CBD) to develop national strategies for the conservation and sustainable use of biological diversity and to stop the extinction of species.
The availability of actual and reliable data regarding the status quo of species or habitats is crucial for these national strategies. Therefore, sound initial inventories and a regular monitoring of habitats and populations are necessary. The research project 'Drones in Biomonitoring' (short: Drones for Nature) investigates the use of drone technology for the use in nature conservation and biomonitoring in the context of biodiversity research. Practical ecological questions and methods in nature conservation and landscape planning, in forestry, agriculture and water management are examined regarding the potential support through the use of affordable prosumer drones. Main goal of the project is the analysis and presentation of aerial systems with the relevant sensors and their assignment to respective monitoring methods in an operation matrix and finally the publication of an online manual of it all. Flights over pastures and agricultural landscapes, over wetlands and swamps, over rivers and rocks and for animal detection are carried out to develop workflows for stable surveys. The whole process from the acquisition of the equipment, over the request of permissions, the flight planning and the respective parameters to the analysis of the obtained data will be prepared. Moreover, the different aerial systems and their use will be tested and evaluated regarding their potential to improve the efficiency of monitoring methods and to broaden the portfolio of data surveys. An additional main focus is the investigation of the disturbance impact of drones to species and to provide specific guidance for it.

SESSION 19

Urban Ecology: Past, Present, Future

CHAIRS: ***Monika Egerer, Leonie Fischer, Sonja Knapp, Michael Strohbach***

The Ecological Society of Germany, Austria and Switzerland turned 50 last year. With this anniversary and the motto “Science in Transition, Science for Transition” in focus, we are compelled to review the development of urban ecology as a “Science for Transition”. Already in the early 1970s, Editor of the Journal Urban Ecology Royce LaNier wrote: “Clearly there is a need to develop settlement patterns more responsive to the biospheric systems which support mankind and to the global needs of the species.” Cities today are faced with huge challenges including the loss of biodiversity, extreme weather events, human-wildlife conflict, and the loss of human-nature experiences. All of these factors are driving the decline of urban ecosystem services, upon which the livability of the world’s cities, and the well-being of its residents, depend. While urban ecology has in recent decades vastly improved our ecological understanding of urban environments, important challenges remain. In this session, we aim to bring together research from diverse topical areas in urban ecology that are contributing to our understanding of the ecology of past and present urban ecosystems and landscapes, and how to manage them for future challenges. The goals of this session include: 1) highlighting the key research projects and key people in urban ecology’s development; 2) discussing the contribution of urban ecology to the field of ecology; 3) reflecting upon the impact of urban ecology to solve real-world problems; and 4) envisioning solutions towards managing biodiverse and functioning urban environments in the next 50 years. The session will be the opening meeting of the revived GfÖ-Specialist Group “Urban Ecology”, and will include an introduction to the Specialist Group and our future plans and ideas. We invite everyone interested to join and meet, and look forward to the ‘Austausch’ with all interested.

19-O-01 - Urban wildflower biodiversity - The role of human actions and natural processes in Zurich

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Cities are dynamic ecosystems in which human actions intertwine with natural processes, mutating, promoting, or impeding them. Plants that occur within cities often seem to exist only at our will. Our priorities and lack of understanding can result in the creation of "Potemkin Gardens"- mirages of beautiful ecological systems hiding a dysfunctional reality. Looking beyond these botanical tableaus, however, reveals that certain species are succeeding in making urban green spaces their own. Seed dispersal, pollination, and colonization are major drivers of plant diversity and biogeography in cities. Our work explores this interplay between human action and biologically driven patterns in wildflowers in Zurich. We examined how design/land-use history have impacted the Zurich's biogeography. We explored the ecological patterns associated with isolation and patch size in determining the biodiversity of green "islands" spread throughout a sea of concrete. Utilizing modern genetic methods, we have examined how species' life histories determine their connectivity and how human sowing may be mixing new genotypes with established urban genotypes. Cities present an opportunity to directly engage with the system's key shapers and drivers. Working with local citizen science network, we created a project to highlight the self-dispersing flower species which grow of their own volition.

19-O-02 - Taxonomic and functional homogenization of farmland birds along an urbanization gradient in a tropical megacity

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Urbanization is a major driver of land use change and biodiversity decline. While most of the ongoing and future urbanization hot spots are located in the Global South, the impact of urban expansion on agricultural biodiversity and associated functions and services in these regions has widely been neglected. Additionally, most studies assess biodiversity responses at local scale (α-diversity), however, ecosystem functioning is strongly determined by compositional and functional turnover of communities (β-diversity) at regional scales. We investigated taxonomic and functional β-diversity of farmland birds across three seasons on 36 vegetable farms spread along a continuous urbanization gradient in Bangalore, a South Indian megacity. Increasing amount of grey area in the farm surroundings was the dominant driver affecting β-diversity and resulting in taxonomic and functional homogenization of farmland bird communities. Functional diversity losses were higher than expected from species declines (i.e. urbanization acts as an environmental filter), with particular losses of functionally important groups such as insectivores of crop pests. Moreover, urbanization reduced functional redundancy of bird communities, which may further weaken ecosystems resilience to future perturbations. Our study underscores urbanization as a major driver of taxonomic and functional homogenization of species communities in agricultural systems, potentially threatening crucial ecosystem services for food production.

19-O-03 - The secret of success: Insights into the ecology of urban red foxes

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Human population is growing steadily and with this growth landscapes have been altered trough anthropogenic activities. Urbanisation is identified as one of the main reasons for biodiversity loss. Vertebrate loss is typically considered to be worst in urbanised areas because of intense and long-term disturbances that permanently alter habitats and depreciate food webs. Nevertheless, there are always animal species that have adjusted to city life, so-called urban dwellers. An outstanding example of success is the red fox (*Vulpes vulpes*). Detailed knowledge of animal communities, food and competition relationships among the species, as well as species movement patterns and health status allow us to better understand the dynamics and predict the resilience of an ecosystem. Identifying the biological traits favouring synurbisation is decisive to inform current management as well as to generate predictions for the future. In order to understand why the red fox is so successful in our anthropogenic world, we have to study different aspects of its ecology in, both, rural and urban settings. Therefore, we investigated the diet, parasite spectrum and resting behaviour of red foxes along an urbanisation gradient in Berlin and Brandenburg (Germany) and revealed habitat dependent differences in red fox ecology. Overall, dietary specialisation and the use of anthropogenic food resources have an overarching impact. If proper food supply has such an extensive influence on the ecology, behaviour and lifestyle of red foxes, management strategies should focus on this topic. Reduced food availability would probably increase the competitive pressure within the fox population, reduce population density and thus also the contact rate between humans, domestic animals and foxes. Human-wildlife conflicts in the city could thus be reduced and the general acceptance of wild animals in the city increased. This could ultimately lead to the sharing of urban areas by humans and wildlife.

19-O-04 - Multi-species assessment of core areas and connectivity of amphibians in human-dominated landscapes

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Habitat degradation, loss and isolation due to rapid urbanization and agricultural productivity keep threatening biodiversity worldwide by reducing the connectivity of resource patches. Such changes in human-dominated landscapes break connectivity, thereby reducing population viability and the organisms' potential to shift their ranges or adapt to new environmental conditions. Furthermore, managing for connectivity requires interventions which consider a broader landscape context. Measures such as Blue-Green Infrastructure (BGI), instruments for green space provision, waterway protection and nature-inspired engineered infrastructures, are emerging mitigation solutions that can form a functional network of (semi-)natural habitats to maintain biodiversity and optimize ecosystem functions. Such measures are especially appealing for amphibians, which are a rich and diverse, yet globally declining vertebrate assemblage. We sought to identify core areas and connectivity corridors for 11 species (6 families) across the Swiss lowlands and opportunities for transforming the urban form into BGI to promote connectivity. Through an ensemble model of habitat suitability linked to circuit theory, we quantified and visualized potential species distribution in the whole study area at fine resolution, including the identification of existing and potential hotspots. This was mainly driven by land-use derived predictors, vegetation, and proximity to water bodies. Variations between species were attributed to distinct ecological strategies and was reflected in the connectivity analysis, where we identified clusters in potential dispersal pathways. At the multi-species level, riparian corridors were particularly important for urban settings. Around 11% of the dispersal pathways overlapped with urban green spaces, 3.4% with anthropogenic land covers, encouraging the development of species-specific and multi-species conservation strategies to protect core areas and promote connectivity.

19-O-05 - Freshwater biodiversity conservation in cities – a multi-scale perspective

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Freshwater ecosystems face severe biodiversity declines, and habitat loss and degradation in urbanised areas is one of the major threats. In order to assess the potential of urban areas for freshwater biodiversity conservation, I investigated patterns of species richness and composition in Central European urban environments. Therefore, I focused on dragonflies, established proxies for freshwater biodiversity. I compiled data from field surveys, databases and a literature review and considered different spatial scales: the habitat, city and landscape scale.

Main findings were that dragonfly species richness can be high and urban assemblages can contain a wide array of regional species at all scales, including species of conservation concern. Dragonfly diversity was determined by structural and spatial heterogeneity of the city's pondscape and surrounding landscape. However, with increasing urbanisation degree dragonfly richness and the proportion of specialists declined strongly.

In conclusion, urban environments in Central Europe have good potential for high dragonfly diversity and dragonfly conservation. But this potential is limited in areas of high urbanisation degree and for some species urban areas cannot substitute natural landscapes. Thus, conservation requires a multi-faceted and multi-scaled view integrating good habitat quality, a diverse bluescape and high landscape heterogeneity. To encounter negative impacts of increased urbanisation degree conservation measures should aim at promoting high structural and spatial heterogeneity at all scales. In addition, the preservation of pristine habitat remnants is crucial to promote regionally characteristic specialists.

19-O-06 - Impact of different landscape factors on the wild bee community of the city of Braunschweig

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The loss of natural and semi-natural habitats in our landscapes over the last decades is considered as a main driver for the decline of wild bee diversity and the associated pollination services. Therefore, it is important to develop measures to promote pollinators in anthropogenic environments.
Urban areas are often considered as bee refuges. However, knowledge about which habitat elements specifically determine wild bee diversity in cities and where supporting measures might be most effective is scarce. Therefore, we examined the urban wild bee community of the city of Braunschweig at 50 sites in 2019. At each site, a set of different coloured pan traps were set up for 24 h in April, June and August.
A total of 1876 bees of 102 species were caught. The majority of the individuals was found in spring, while in early summer, the highest number of species was observed. Using this data set, different landscape factors affecting the bee community in the city were analysed.
Urban structure affected bee communities at different scales. On the one hand, bee species richness and abundance were related to impervious surface in a hump-shaped manner at a 100 m scale. On the other hand, species richness and abundance linearly increased with the proportion of allotment gardens at the 300 m scale.
Based on the resulting knowledge, supporting measures can be improved to increase attractiveness of urban areas for wild bees.

19-O-07 - Urban garden research in two German cities

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Urban gardens are novel ecosystems that can create insect biodiversity hotspots through the provision of flowering plant diversity compared to surrounding areas. Even though the relationships between flowers and flower-visiting insects are manifold, most studies on flower-visitors do not distinguish between insect behaviours during monitoring. For example, bees and hoverflies depend on flowers as a primary food resource for themselves or for their offspring, while other insect taxa use flowers mainly as shelter or as a landing platform. We suggest a new methodological approach to identify flower-visiting insects as potential pollinators depending on the type of flower interaction.
We evaluated (1) which insect taxa were visiting flowers and (2) how they interacted with the flowers in 30 urban gardens in Munich and Berlin (Germany). Our aim was to identify those insect taxa with potentially the highest importance to pollination in urban gardens. We documented all flower-visiting insects observed within 30 minutes within a 20x20 m plot of each garden. For each individual, we recorded if the flower visitor was in contact with the flowers' stamen or stigma, and if the interaction was active (i.e. collecting pollen or feeding) or passive (e.g. random contact during flower landing), indicating the importance of the interaction for pollination function.
This is a first approach to characterize the mechanisms of insect-flower interactions in urban gardens, designed to give a preliminary overview of the local pollinator-network. Before ultimately defining the importance of an insect species as a pollinator, one should also carefully consider other aspects (e.g. insect species abundance and body morphology). This work presents a new simple method to fill research gaps on the importance of plant-insect interactions, mutualistic relationships and ultimately pollination function in urban ecosystems.

19-O-08 - Botanical gardens as biodiversity hotspots and multipliers in urban areas

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Botanical gardens have a wealth of functions. They cultivate valuable plant collections, which serve scientific and teaching purposes, harbour diverse research projects, are dedicated to the conservation of plants, and offer environmental education and recreation to the public. At the same time, as close to nature managed urban greens, they offer habitats for a large diversity of native organisms in urban environments.
A survey across 20 botanical gardens of Germany, Austria and Switzerland revealed a number of up to 2200 species per garden so far recorded by the gardens. Especially the taxonomic groups of bees, birds, seed plants and amphibians are often and thoroughly recorded in the participating botanical gardens. These groups show a large species diversity as well as a high number of red list species and demonstrate the potential of botanical gardens and other urban greens to serve as habitats for a large number of even sometimes endangered organisms in urban areas. Prerequisites might be rich floral resources during the whole growing season, habitat diversity and structurally rich woody vegetation. Botanical gardens include biodiversity in their environmental education programs and can serve as multipliers for information concerning biodiversity issues as well as for near to nature gardening in urban landscapes.

19-O-09 - Forecasting the cooling potential and drought resistance of street trees by species' functional traits

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The ongoing climate change has a vast influence especially on urban areas. Due to highly sealed surfaces, building structures etc., urban areas show much higher air temperatures in comparison to their surrounding countryside (so-called urban heat island effect). An increase in extreme weather events such as droughts and heat waves exacerbate the situation in urban areas, and thus in places where the majority of the world's human population lives.
To mitigate those effects and to adapt cities to future climate beams the focus towards the already existing as well as possible future urban green infrastructure. In particular, urban trees play a major role in this context. Beside the quite effective regulation of temperature by transpiration and shade, they provide diverse ecosystem services including recreational and aesthetic effects, sequestering of carbon, filtering of air pollutants, etc. But as only a healthy and vital tree is capable of providing services, it is necessary to find species, which can cope with extreme heat and limited water supply.
In this context, we investigate the potential of plant functional traits as indicators for the cooling effect and drought resistance of street trees. Functional traits reflect the adaptation of species towards their environment (e.g. thicker leaves in arid areas) and can be linked to ecosystem services. Across five tree species/cultivars at nine sites in the city of Leipzig, Germany, we measured, beside the characteristics of the sites (e.g., degree of sealing), climatic differences between spaces under tree crowns vs. spaces not covered by tree crowns (e.g., air temperature, air humidity), as well as several physiological and morphological traits of tree species (e.g. leaf water potential (predawn/midday), specific leaf area, stomata per mm^2 etc.). In the talk, first results linking traits to climatic parameters will be presented.
Developing trait-based indicators of both urban trees drought resistance and cooling potential is of high importance in the face of climate change and the predicted consequences for urban areas. It can provide a helpful instrument for urban planners.

19-O-10 - Urban biodiversity and ecosystem services dashboards to inform planning and governance: a review of best practices

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Transforming cities and metropolitan region developments towards more sustainable pathways requires information on the state and change of biodiversity and ecosystem services. Dashboards could arguably provide helpful transition support to stakeholders, planners, and decision-makers. They are understood here as a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance. Despite the importance of dashboards in environmental planning and governance, there remains a paucity of evidence on how dashboards might contribute to sustainable urban transformations by providing collective data, supporting analytical reasoning and enabling data-driven decision making. Therefore, this proposed contribution aims to identify and review novel case studies of dashboard applications to inform urban planning and governance with information on biodiversity and ecosystem services. Our research design includes the development of a conceptual framework of key attributes of biodiversity and ecosystem services dashboards, the identification of globally leading dashboard applications, and a comparative assessment of those cases. Our preliminary results show the increasing application of biodiversity and ecosystem services dashboards globally. Moreover, the reviewed best practice dashboards indicate that the performance of dashboards varies based on different metrices and these metrices highly depend on the overarching objectives of dashboards. Our results shed light on the state-of-the-art of dashboard applications and will provide suggestions for key research needs to further advance dashboards to inform planning for nature and people.

19-P-01 - Interaktionen der urbanen Vogelgemeinschaft mit den Strukturen urbaner Gemeinschaftsgärten

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Vögel sind ein integraler Bestandteil der urbanen Tierwelt. Aktuell findet die Avifauna mit urbanen Gemeinschaftsgärten zunehmend Grünräume im Stadtgefüge vor, die durch eine besondere Vielfalt hinsichtlich des Vegetationsbestandes und der Bewirtschaftung gekennzeichnet sind. Während für andere städtische Grünflächentypen wie Parks oder Plätze bereits umfassende Erkenntnisse über deren Qualitäten als Lebensraum und deren Nutzungspotenziale für Vögel vorliegen, ist dies für den speziellen Fall der urbanen Gemeinschaftsgärten aktuell noch nicht der Fall.
Um diese Forschungslücke zu schließen, haben wir zwei Forschungsfragen untersucht. Zum einen untersuchten wir, welchen Einfluss die physischen Eigenschaften der urbanen Gemeinschaftsgärten (Baumartenvielfalt, Baumanzahl, Kronendachbedeckung, Anzahl menschengemachter Hilfsstrukturen, Grad der Versiegelung) auf die Abundanz und Artenvielfalt von Vögeln haben. Zum anderen war für uns von Interesse, mit welchen Strukturen und Objekten die Vögel in urbanen Gemeinschaftsgärten in Kontakt treten und interagieren.
Wir untersuchten im Zuge der Studie 15 urbane Gemeinschaftsgärten in München und Freising. Diese wurden jeweils zweimal im Zeitraum zwischen Mai und Juni 2021 mittels einer 20-minütigen Punktkartierung untersucht. Dabei wurde für jedes anzutreffende Vogelindividuum aufgenommen, welcher Art es angehört und mit welchen der fünf zuvor gebildeten Strukturkategorien (Boden, Bäume, Sträucher, menschengemachte Hilfsstrukturen, sonstige anthropogene Strukturen) es im urbanen Gemeinschaftsgarten in Kontakt trat.
Die Ergebnisse der Studie liefern Erkenntnisse darüber, welche Strukturen in und welche physischen Eigenschaften von urbanen Gemeinschaftsgärten für die ansässige Vogelfauna von Bedeutung sind. Basierend darauf können somit Handlungsempfehlungen für die zukünftige Gestaltung urbaner Gemeinschaftsgärten gegeben werden.

19-P-02 - Owners' perception does not match actual ground-dwelling invertebrate diversity in their garden

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Urban domestic gardens are important for human well-being, biodiversity and other ecosystem functions. Biodiversity-promoting initiatives would benefit from their owners being aware of the state of biodiversity in their gardens. We examined whether garden owners' perceptions match actual biodiversity in their gardens and whether perceptions are influenced by the owners' ecological knowledge and the main function assigned to their garden. We used a structured interview to assess the motivations and biodiversity knowledge of owners of 33 domestic gardens in Basel and its surroundings and related them to a survey of native plants and several groups of ground-dwelling invertebrates in their gardens. Owners prioritizing biodiversity promotion had gardens with high habitat type richness, while owners with a high priority for garden designing had gardens with low habitat type richness. The garden owners' perceptions of both native plant and overall invertebrate diversity were not correlated with actual diversity data for native plants and ground-dwelling invertebrates. The garden owners' knowledge on different taxonomical groups varied widely. However, the perceptions of the abundance of invertebrate groups by garden owners with good biodiversity knowledge were not more accurate than those from owners with less knowledge. Asked about potential improvements for biodiversity promotion in their gardens, most owners suggested creating new habitat types. However, 21 % of owners stated that no further improvement for native biodiversity is possible in their garden, even though many of these gardens had invasive non-native plant species. Our study showed that many owners are motivated to promote native biodiversity in their garden. However, most owners are limited by gaps in their ecological knowledge. Initiatives to further biodiversity-friendly gardening should thus transfer knowledge.

19-P-03 - Monitoring of insect diversity on Berlin's center roadsides

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Urban greenspaces such as roadsides are often not considered as valuable habitat for biodiversity. This is because they are relatively understudied. It is important to monitor and characterize the biodiversity on city roadsides to better understand the role that they play in supporting biodiversity and how this could inform urban greening strategies. This research project aimed to investigate the biodiversity of insects in relation to different management strategies on three selected center roadsides in Berlin, Germany, in cooperation with the Institute of Garden and Agriculture of the Humboldt University. The observatories were divided into a control area and an area where the original soil was changed with sand. Over four years in the same roadsides, we collected insects with hand nets monthly from April to October, and documented the diversity of insects. We documented in total nearly 290 species of six orders. We found that the species inventory between the observatories is very different. Additionally, the recorded species diversity between the control roadside and sandy soil treatment roadside is very different – we found significantly higher species diversity on sandy soil. Probably, the isolated stripes between the roads with a high density of traffic, are more or less undisturbed, and it seems to be the reason for this high diversity. However, the abundance of species is low in this roadside. Of note, new species and some species with a southern European origin were documented, potentially suggesting some indicators of climate change. The common species of these areas, which were barely collected in the past 80 years, offer valuable material for morphometric analyses. Future monitoring will aim to document new species, species succession on the sandy soil treatment, and changes in diversity patterns. In sum, this collection is a unique urban ecological time document for Berlin. The resulting collection can support the Green Space Offices recommendations for the grassland care management, especially for the interval of mowing, to protect these valuable inner-city habitats.

19-P-04 - Potential contributions of restored urban road verge vegetation to climate regulation and enhancement of resources for urban flower-visitors

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The increasing pace of urbanization worldwide affects biodiversity and largely demands ecosystem services (ES). To decrease the negative effects of urbanization, urban green infrastructure (UGI) has been proposed as a suitable nature-based solution that provides benefits to humans, increase climate change adaptation, and integrate biodiversity into urban systems. In our project, we aim to study the ecological functioning and the potential of small patches of restored grasslands in urban road verges for climate adaptation and biodiversity fostering. Along a gradient of urbanization in Munich city, 23 patches of native grassland vegetation were established based on ecological criteria and managed with a single cut per year. In the second year of development, we assessed regulatory ES of these, i.e. microclimate at the surface level and water infiltration capacity, and compared them with those offered by road verge lawns (controls). In addition, the offer of floral resources for pollinators was quantified and compared. We found that surface temperature decreases are greater in restored grasslands than in lawns when compared to sealed surfaces and the vegetation cover and height might explain this decreasing effect. The infiltration rate of water was highly variable and not significantly different between lawns and restored grasslands. Notwithstanding infiltration tended to be higher in well-established lawns and lower in very urban areas. Additionally, restored road verge vegetation offers more flower resources, which translates in larger abundance of flower-visiting insects. Even though restoring and adjusting the management of urban grasslands increases alternatives to develop climate resilient cities and pollinator-friendly greenspaces within the UGI, some expected positive effects might not be noticeable in the short term. The monitoring of the ecological performance is necessary to properly assess benefits and potential arising trade-offs.

SESSION 20

Computational Methods and Models in Ecology

CHAIRS: ***Florian Hartig, Lionel Hertzog, Gudrun Wallentin***

In this session we welcome contributions advancing all aspects of ecological modelling from statistical approaches (i.e. new R packages, method comparisons) to process-based models (i.e. IBMs, population models). The aim of the session is to portray the large diversity of models and methods used in ecology, but also to foster exchanges between modellers and applied ecologists. Given the theme of the conference, we would also particularly welcome contributions reflecting on the evolution in ecological modelling practices over the last 50 years and on the new questions and research avenues that opened up due to advances in modelling techniques. This session will be organized in cooperation with the AK computational ecology.

20-O-01 - ODMAP: a tool and protocol for standardized reporting of species distribution models

***Damaris Zurell*[1]**

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Species distribution models (SDMs) have established as the most widely used modelling framework in ecology and conservation. Part of their success certainly lies in the ready availability of easy-to-use software packages as well as comparably simple data requirements. However, as editor and reviewer for journals I have often seen that documentation of SDMs was poor, which makes it hard to assess their adequacy for the question at hand. To amend this, I assembled a large group of SDM users and developers to design a standard protocol for reporting SDMs. We call this the ODMAP (Overview, Data, Model, Assessment and Prediction) protocol, as its components reflect the main steps involved in building SDMs and other empirically-based biodiversity models. The ODMAP protocol provides several benefits to authors, reviewers, and evaluators. It serves as quick guide to authors for designing their study and taking the main modelling decisions, and the structured format for documentation and communication increases transparency and reproducability and facilitates peer review and expert evaluation as well as future meta-analyses. Here, I briefly explain the elements of ODMAP and of our web-based Shiny app, and discuss how it may integrate with other developments in the field.

20-O-02 - Scalable and accurate (Joint) Species Distribution Modeling of big community data using the R-package sjSDM

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Joint Species Distribution models (jSDMs) explain spatial variation in community composition by contributions of the environment, biotic associations, and possibly spatially structured residual variance. They show great promise as a general analytical framework for community ecology and macroecology, but current jSDMs scale poorly on large datasets, limiting their usefulness for big community data.

Here, we present the R package sjSDM, which implements a scalable method to estimate jSDMs with a Monte-Carlo approximation of the joint likelihood. The numerical approximation is based on PyTorch and can be calculated on CPUs and GPUs alike. sjSDM is orders of magnitude faster than existing jSDM packages, and can be scaled to large community datasets,without deterioration of the quality of the inference.

We will show benchmarks of sjSDM, demonstrate its simple and intuitive programming interface, and highlight other features, such as modeling spatial effects, and separating the different contributions of the effects (variation partitioning).

20-O-03 - RangeShiftR: Individual-based population modelling and simulation of spatial eco-evolutionary dynamics in R

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Reliably modelling the demographic and distributional responses of a species to environmental changes can be crucial for successful conservation and management planning. Process-based models have the potential to achieve this goal, but so far they remain underused for predictions of species' distributions. Individual-based models offer the additional capability to model inter-individual variation and evolutionary dynamics and thus capture adaptive responses to environmental change.
We present RangeShiftR, an R implementation of an individual-based modelling platform which simulates eco-evolutionary dynamics in a spatially explicit way. The package provides fast and flexible simulations as it is based on the C++ software RangeShifter, offering all its modelling complexity for demographic, dispersal and evolutionary processes. The package features additional auxiliary functions to support model specification and analysis of results. In this presentation, we provide an overview of the package's functionality, describe the underlying model structure with its main components and present a short example.
The RangeShiftR package facilitates the application of individual-based and mechanistic modelling to eco-evolutionary questions by operating a flexible and powerful simulation model from R. The project's website (https://rangeshifter.github.io) provides further information such as elaborate tutorials and a comprehensive user manual. The complete source code is published under a public licence, making adaptations and contributions feasible.

20-O-04 - Parameterization of a process-based model for range dynamics of plant species using the virtual ecologist approach

Jana Blechschmidt[1], Juliano Sarmento Cabral[1]

[1]University of Würzburg, Würzburg, DE

Process-based models incorporating demographic, dispersal and metabolic processes can be a powerful tool to forecast species' ranges in the future for different climate and land use change scenarios, as well as to assess the effects of conservation measures on populations. However, for adequate forecasts, it is necessary to calibrate or to estimate the values of the species-specific parameters of the processes implemented (e.g. niche preferences, dispersal ability, demographic traits). Because empirical data for several if not most parameters is not available for the majority of species, these parameters must be estimated (as free parameters), for example, via optimization or parameterization methods. Still, parameterization of these models is challenging, as the amount of free parameters can be high and computational runtime prohibitive. Here, we evaluate several parameterization strategies via the virtual ecologist approach applied to a recently developed model for plant species. The model integrates species-specific parameters such as preferred environmental conditions, biomass, and dispersal ability with demographic rates (e.g. reproductive and mortality rates) derived from local temperature and biomass via the metabolic theory of ecology. We ask 1) whether it is possible to fit such a model to data; 2) what the data requirements are; 3) whether these requirements vary depending on the species. To answer these questions, we simulate 30 random combinations of species-specific parameters as virtual species on five random European landscapes and sample the surviving species through key sampling schemes that might resemble availability of empirical data: i) spatially-restricted vs. full coverage of occurrence data; ii) spatially-restricted vs. full coverage of abundance data; iii) i and ii with additional temporal (i.e. time-series) and/or functional (trait) data. These virtual data are then fed to an optimization algorithm to fit the model and the retrieved parameter estimates are contrasted with the virtual truth. Our results will serve as a guide on which data may suffice for satisfactorily estimating parameters of process-based range models for real-world species.

20-O-05 - Modelling the spread- and establishment potential of climate-sensitive plant pests for proactive phytosanitary risk analyses

Bastian Hess[1], Peter Baufeld[1], Arno de Kock[2], Anto Raja Dominic[2], Björn Lutsch[4], Christoph Menz[3], Stephan Nordheim[2], Anne Reißig[4], Jörn Strassemeyer[2], Timm Waldau[2], Anne Wilstermann[1], Olaf Zimmermann[4], Gritta Schrader[1]

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Climate-sensitive pests are species with a risk-potential expected to change significantly as a result of the climatic changes observed to date and anticipated for the future. The Model for spatio-temporal Plant Pest Spread Simulations (MoPSi) is being developed to focus on climate-sensitive species and to close a gap in the assessment of new pests. Up to now, changes in their long-term risk potential due to climate change have been difficult to assess and were therefore not sufficiently taken into account in phytosanitary pest risk analyses. The prediction of the establishment potential and possible spread of pests and evaluation of different environmental- and management scenarios is of great ecological and economical importance and essential for pest management. We are developing a simulation model that will allow these predictions and scenario analyses, and that will be used as a standard procedure for such risk analyses. The objective is to create a transferrable, generalized open source model framework that is easy to extend and couple with individual host plants- and climate data sets as well as new presence/absence data of the pest. The model will also allow for a transferability to many taxonomic pest groups so that it can be enhanced by different sub-models as well as species-specific functions and parametrization. The dynamic model consists of three sub-models and predicts the probability of survival, establishment, and the possible spread of the pests based on species-specific spread parameters and distribution properties. The results of the model are visualized in the form of distribution- and risk maps. Identified high-risk areas for pest establishment can support the planning of survey activities. Furthermore, the model-output can used as a decision-support tool for example for plant growers and breeders.

20-O-06 - A new method to assess the area of applicability of spatial prediction models

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Machine learning algorithms have become very popular for spatial mapping of the environment due to their ability to fit nonlinear and complex relationships. In a typical predictive modelling task, ecological field data are used to train machine learning models using spatially continuous predictor variables, often derived from remote sensing imagery. In this way, a large number of ecological spatial products have been developed including global biodiversity, soil properties or potential tree cover.
However, the quality of such large-scale products has also been increasingly called into question. A large challenge during spatial predictive mapping is that predictions are made beyond the geographic space of the training data, which in many cases goes along with new environmental predictor properties. Machine learning models, however, can only make reliable predictions for predictor properties that are comparable to those observed during model training. We therefore argue that the "area of applicability" (AOA) of prediction models should be assessed, to avoid making predictions into "unknown space" which cannot be considered reliable.
We propose a simple method to derive the AOA of spatial prediction models that we define as the area where we enabled the model to learn about relationships and where validation performance measures hold. The method is, in its basic concept, based on distances in the multidimensional predictor space. In this contribution we show how the AOA can be estimated and used in the context of ecological predictive mapping.
Communicating the AOA is important to avoid mis-planning when predictive mapping is used as a tool for decision making, as well as to avoid propagation of massive errors when spatial predictions are used as input for subsequent modelling. We argue that predictions should therefore be limited to the area of applicability of the model.

20-O-07 - Arresting succession to create alternative ecosystem states

Amy Schroeder[1], Steven I. Higgins[1]

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Ecosystems with qualitatively different structures and dynamics can exist under the same climate and edaphic domains. The processes that allow alternative ecosystem states (AES) to emerge are however poorly understood. We argue that progress could be made by explicitly analyzing the development of AES in the context of succession theory. We hypothesise that AES is the outcome when succession is arrested. We use a model system that is capable of describing autogenic succession driven by changes in light availability. We go on to show how such succession sequences can be influenced by consumption processes, such as grazing. This model infers that processes that influence trade-offs between the growth and mortality rates of species and the extent to which these rates are influenced by ecosystem-level processes that - species engineer themselves – determines the extent to which alternative ecosystem states can develop. Our analysis shows how plant traits and community-level processes interact to determine whether alternative ecosystem states can emerge.

20-O-08 - Modelling mixed species regeneration below a pine dominated overstory under dry and nutrient-poor conditions in Brandenburg

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Besides all progress achieved in computer-based forest modelling, describing the dynamics of forest regeneration in multi-layer mixed species forests remains difficult. This is a critically issue, particularly when the natural change of species composition and forest structure should be predicted as often required to forecast the mid- and long-term effects of climate change or to develop management measures for increasing forests resilience. In the frame of the VERMOS project, we aim to understand the multiple interactions between forest regeneration, overstory, ground vegetation (shrubs and grasses) and soil, taking a deeper look at below-ground competition for water. By developing the individual-based regeneration model BETTINA-AYSE, we are specifically interested in a mechanistic understanding of the dynamics of mixed species regeneration below an overstory of Scots pine (*Pinus sylvestris* L.) under increasing dry stress conditions as already observed for our study sites located in Brandenburg (North-East Germany).
BETTINA-AYSE describes water uptake of single trees and their local interactions with neighbouring plants and the soil. In the model, plant water uptake is limited primarily by water availability, but subsequent biomass allocation depends also on light, analogous to optimal partitioning theory. Below-ground competition for water considers the vegetation-soil feedback, and the local depletion of this resource by neighbouring plants. The model is thus rather based on first principles than on their phenomenological description as done in common distance dependent approaches such as the Zone-Of-Influence or the Field-Of-Neighbourhood approach.
Our simulation experiments confirm the importance of this mechanistic description for predicting forest regeneration under strongly limited water resources. We will discuss pros and cons of this approach as well as its potential for future growth models in regards to climate change.

20-O-09 - Quantifying the contribution of habitats and pathways to a spatially structured population facing environmental change

Brady Mattsson[1], Christina Sample[2], Joanna A. Bieri[3], Benjamin Allen[2], Yulia Dementieva[2], Alyssa Carson[2], Connor Higgins[2], Sadie Piatt[2], Shirly Qiu[2], Summer Stattford[3], Jay E. Diffendorfer[4], Darius J. Semmens[4], Wayne E. Thogmartin[5]

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Environmental disturbance and management differentially affect population dynamics. Such differential outcomes are particularly difficult to quantify for spatially structured populations because the consequences carry through to other locations due to species movement. We developed an estimator, G, for measuring the contribution of a habitat or pathway to network-wide population growth rate in the face of environmental change. This approach is unique from other contribution metrics as it quantifies effects of modifying vital rates for habitats and pathways in perturbation experiments. Perturbation treatments may range from small perturbations to complete habitat or pathway removal. We demonstrate the approach using a simple metapopulation example and case studies of eastern monarch butterflies and northern pintail ducks in North America. For both species, the magnitude of environmental change influenced ordering of node contribution. Moderate disturbance in the central-breeding range of monarch butterflies was concordant with observed declines, but severe degradation in the wintering area had a disproportionate effect on population growth. Similarly, pintail breeding areas are most important under small disturbances but large degradation causes wintering areas to become most critical to population growth. This approach provides for more efficient management interventions that proactively mitigate impacts of expected disturbances to spatially structured populations.

20-O-10 - Estimating ecosystem functions of non-vascular vegetation by process-based modeling

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Non-vascular vegetation, such as lichens, mosses, or terrestrial algae and cyanobacteria, carry out key functions in multiple ecosystems around the world. In contrast to vascular vegetation, however, the organisms are relatively little researched. In particular, quantitative understanding on their ecophysiology is limited, and only a few large-scale estimates on their biogeochemical effects are available. A better assessment of relevant environmental constraints on non-vascular vegetation is, however, urgently needed, since climate change will likely substantially affect the organisms. Processed-based modeling approaches may serve here as a useful method to improve understanding on future abundance and diversity of non-vascular vegetation. Hypotheses on the relevance of climatic factors may be tested in model experiments which are difficult to realize in field experiments. Moreover, process models which are validated at the local scale for limited periods of time can extrapolate vegetation properties in space and into the future. Here I present a numerical modeling approach, the LiBry model, which is specifically designed for non-vascular vegetation. The LiBry model accounts for key ecophysiological processes which control the carbon balance, and, consequently, the growth of the organisms at the individual level. By simulating a large number of different functional types, the model explicitly represents physiological diversity of non-vascular vegetation. The carbon balance is then used as the criterion for relative success in the process of natural selection. In this way, effects of climate change on community composition and ecosystem functions of non-vascular vegetation can be represented in a quantitative way. I provide an overview on large-scale estimates of impacts of the organisms on global biogeochemical cycles, derived by LiBry. Moreover, I show examples how sensitivity analyses using LiBry reveal key environmental drivers of non-vascular functioning.

20-O-11 - Predicting the functional traits composition shifts of non-vascular vegetation along climate gradients using a process-based model

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Non-vascular vegetation is distributed all over the world, and may substantially contribute to ecosystem services, particularly in those environments where climatic conditions inhibit high abundance of vascular plants, such as warm or cold dry regions or alpine areas. Global climate change will likely alter diversity and community composition of non-vascular vegetation in multiple ecosystems. A range of experiments have confirmed the relevance of different environmental conditions for non-vascular communities. However, the mechanisms of convergence of certain functional traits in the local community are still poorly understood, which makes it difficult to assess consequences of climate change for global diversity of non-vascular vegetation. A key criterion for survival of any photoautotroph is the maintenance of a positive carbon balance in the long-term. Therefore, we aim at determining which relations between environmental factors and traits are most relevant for the carbon balance of non-vascular organisms. Here we applied the process-based non-vascular vegetation model LiBry at six study sites which differ in their climatic conditions to investigate the most essential trait-environment relations along climate gradients and the underlying mechanisms. The LiBry model mimics environmental filtering to predict the local functional trait composition based on climate forcing data and habitat properties, such as soil and land surface properties. The model provides insights into the underlying factors and physiological processes determining differences in trait composition and distribution along climatic gradients. We found that under different climate conditions, the control traits of carbon balance are same, namely thallus height, maximum water storage capacity, specific area as well as metabolic cost rate, even though their distributions slightly variate. In general, both the relations between water availability and water-related properties, and also between light intensity and light absorption-related traits are essential for estimating carbon assimilation and survival at all sites. However, in addition to climate factors, also seasonal acclimation of physiological traits and the simulation of competition are highly relevant for the selection of key functional traits of the carbon balance under climate gradients.

20-O-12 - Phenological traits foster persistence of mutualistic networks by promoting facilitation

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Morphological and phenological traits are key determinants of the structure of mutualistic networks. They both create forbidden links, but phenological traits can also decouple interaction in time. While this difference likely affects indirect effects among species and consequently network persistence, it remains overlooked. Here, we (i) use dynamic models to explore to role of phenology in network persistence and (ii) evaluate our models with a dataset of plant-hummingbird interactions as a test of empirical patterns.
We show that simulated networks structured by phenology favor facilitation over competition within guilds of pollinators and plants, thereby increasing network persistence, while the opposite holds for simulated networks structured by morphology. We further show that such buffering of competition by phenological traits mostly benefits specialists, which are otherwise the most vulnerable species, and which propagate the most positive effects within guilds and promote nestedness. Then we used plant-hummingbird interaction networks to parametrize our dynamic models and see empirical seasonal structure favor facilitation over competition. We show that the seasonal structure of plant-hummingbird interactions strongly affects network persistence and resilience. Taken together, our results indicate that phenological traits are key to understand mutualistic community stability, while it is widely neglected in interaction network analyses.

20-O-13 - Simultaneously estimating food web complexity and structure with uncertainty

Anubhav Gupta[1], Owen L. Petchey[1]

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1) Food web models explain and predict the trophic interactions in a food web, and they can infer missing interactions among the organisms. The allometric diet breadth model (ADBM) is a food web model based on the foraging theory. In the ADBM the foraging parameters are allometrically scaled to body sizes of predators and prey. In Petchey et al. (2008), the parameterisation of the ADBM had two limitations: (a) the model parameters were point estimates, and (b) food web connectance was not estimated.
2) The novelty of our current approach is: (a) we consider multiple predictions from the ADBM by parameterising it with approximate Bayesian computation, to estimate parameter distributions and not point estimates. (b) Connectance emerges from the parameterisation, by measuring model fit using the true skill statistic, which takes into account prediction of both the presences and absences of links.
3) We fit the ADBM using approximate Bayesian computation to 16 observed food webs from a wide variety of ecosystems. Connectance was consistently overestimated in the new parameterisation method. In some of the food webs, considerable variation in estimated parameter distributions occurred, and resulted in considerable variation (i.e. uncertainty) in predicted food web structure.
4) We conclude that the observed food web data is likely missing some trophic links that do actually occur, and that the ADBM likely predicts some links that do not exist. The latter could be addressed by accounting in the ADBM for additional traits other than body size. Further work could also address the significance of uncertainty in parameter estimates for predicted food web responses to environmental change.

20-O-14 - Digital phenotyping of plant individuals and communities in trait-based ecology

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Plant phenotyping in ecological studies is dominated by "low-throughput" methods such as field measurements of specific traits. However, mostly in agricultural research and applications, "high-throughput phenotyping" became standard. Adopting such methods for ecological trait-based studies may provide novel insights and a more complete view on the phenotypic properties of plant communities. We customized the plant scanner PlantEye F500 (Phenospex, Heerlen, The Netherlands) for field applications and scanned whole plant communities and individual plants. Structural (3D point cloud) and multispectral information resulting from these scans was predictive for land use management and other abiotic factors. Thus, digital plant phenotyping is a fast and reliable tool to evaluate the state of plant communities, which reduces the work load associated with trait measurements, adds additional meaningful traits to standard measurements and provides data for future machine learning approaches for feature selection. In conclusion, the mobile version of the PlantEye F500 is suitable for lab, greenhouse, and field applications and provides novel and valuable data for ecological studies.

20-O-15 - A model method for the spatial distribution of agricultural host plants to support pest modelling

Timm Waldau[1], Peter Baufeld[2], Arno de Kock[1], Anto Raja Dominic[1], Bastian Hess[2], Björn Lutsch[4], Christoph Menz[3], Stephan Nordheim[1], Anne Reißig[4], Jörn Strrassemeyer[1], Anne Wilstermann[2], Olaf Zimmermann[4], Gritta Schrader[2]

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In the course of climate change, it has become apparent that once non-native species, including pests, will establish themselves in areas that were originally climatically unfavourable for them. The risk potential that can emanate from these species is also being investigated in Germany within the framework of plant health risk analyses. Mathematical models, which can be used to calculate the spread of a new species, offer a way to effectively support risk assessment and identify hazards in advance. Besides climatic suitability, the presence of host plants is also crucial for establishment of pests in a region. For cultivated plants some of this information is collected in Germany on a regular basis (IACS - data) and provides information on land use, cultivation conditions and spatial distribution. However, the usability of these data is severely limited by legal requirements or is only available in aggregated form and can therefore only be used for specific research questions. Due to these limitations, a procedure was developed within the framework of the joint project "ProgRAMM" that spatially maps the distribution of agricultural crops on field level throughout Germany. Two models were developed on the basis of freely available data (ATKIS, DeStatis, AgrarAtlas): (1) a stochastic model based on the method of Strassemeyer & Golla (2018) and (2) a mathematical model using linear programming by considering cropping conditions.
The results were validated using freely available IACS data of two federal states of Germany. Using the model, we will assess different cropping scenarios or future crop distributions related to climate change. Such crop distribution maps are a valuable source of information not only for pest risk analyses but also for land use analyses.

Reference: Strassemeyer J, Golla B (2018) Berechnung des Umweltrisikos der Pflanzenschutzmittelanwendungen in den Vergleichsbetrieben mittels SYNOPS, *Gesunde Pflanzen* 70 (3):155-166

20-O-16 - Matching species names in biodiversity databases: database relationships, tools, pitfalls and best practices

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One of the biggest challenges in biodiversity data integration is maintaining a consistent taxonomy of species names associated with different information sources. In an attempt to unify taxonomy across the tree of life, multiple initiatives have proposed authoritative lists of taxa groups that can be used as taxonomic references to validate taxa names. However, despite significant efforts in creating a single authoritative list of the world's species taxonomy unification has mainly advanced through multiple independent efforts with different aims and scopes. Driven by the demands in data harmonization, supported by a rapid diversification of computer programming languages and growth of algorithm efficiency, multiple tools that can be used with different purposes across taxonomic harmonization are available. This has generated a diverse "toolbox" but lacking a guideline how to combine these tools in an efficient and meaningful workflow. Here we present and discuss main steps towards robust & meaningful taxonomic name harmonization workflows. We review taxonomic backbones, tools and R packages and show how they depend on and interact with each other. We introduce a shiny app that guide users through the jungle of tools and taxonomic information. We suggest best practices for taxonomic name harmonization for end users, tool developers and taxonomic backbone data owners.

20-P-01 - Effects of landscape configuration on community stress and functional traits

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Organism traits are known to be sensitive to landscape context. Certain landscape structures and configurations may promote combinations of traits that contribute to greater maladaptation and stress in communities in these landscapes. On the other hand, certain configurations may promote traits that contribute to greater resilience in the face of a changing environment.

I explored the relationship between landscape configuration and community functional trait distribution and maladaptation using a spatially explicit, individual-based, metacommunity model. Organisms possess traits defining niches for two different environmental attributes, and dispersal traits defining the frequency and distance of dispersal (nearest neighbor or random global dispersal). Both environmental attributes vary spatially and one can vary temporally as well.

Simulation results show a consistent relationship between a patch’s deviance from the landscape mean and the functional traits and maladaptation within a patch, a relationship which grows stronger with increasing spatial variance. Maladaptation and tolerance are greatest in more extreme patches, indicating that the inhabitants are habitat generalists. Patch extremeness is, likewise, associated with greater dispersal chance, but is inconsistently associated with dispersal distance. In many instances, the most dispersive individuals are primarily short distance dispersers.

Results suggest that organisms in extreme patches may be at greater risk of extinction under climate change as such organisms are often already under high stress. This may be compounded by short distance dispersal tendencies, which may prevent range shifts to more favorable areas. Poor adaptation may also render such communities vulnerable to invasion, while specialists may have secondary habitat requirements that limit their ability to establish elsewhere in the landscape. Alternatively, some organisms may experience competitive release, at least in the short term.

20-P-02 - The development of the ecological niche concept

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We here present a systematic study on the concept of ecological niche. Ecological niche has been described in various ways; from habitat to role and from biotope to hypervolume. Although niche has many different definitions, it remains one of the most fundamental concepts in ecology. Our aim is to show how the use of this term has changed over time in the field of ecology, using text mining methods. We focus on literature published during the last 50 years, to match the anniversary of GfÖ. We analysed over 8,000 publications by applying a topic modelling algorithm on their abstracts. Topic modelling allows the extraction of thematic topics from text corpora. By incorporating publication year in this analysis, we were also able to detect the current trend of each topic (i.e. increasing or decreasing). In addition, we created networks based on keywords' co-occurrences, in order to show the composition of the topic communities and their degree of connectivity. This integrative presentation of the development of the ecological niche concept provides an overview of how dynamics changed over time. Not only does it make possible to detect knowledge gaps, but also facilitates the discussion of where can scientific advances lead us in the future.

20-P-03 - Agent-based-model on population development of *Carabus auratus* within agricultural landscapes

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Insect decline in agricultural landscapes has developed into a central concern in biodiversity research. Political actors demand clear-cut advices on a practical level, such as minimum requirements for beneficial arthropods within a specific landscape context. While the responsibility of intensive agriculture for the decline is supported by an abundance of studies, disentangling the complexity of landscape composition, configuration and the local field management is challenging. Agent-based models (ABMs) step in where field studies or monitoring data are not available or too time-consuming. Provided some real data exist and important behavioural patterns of a species are known, ABMs enable the forecasting of spatial and temporal effects of landscape interventions and herewith explain possible mechanisms behind trends in population developments.

As model organism, we chose the well-studied group of carabids and within that group *Carabus auratus*, typical of less intensively managed arable land. It obligatorily relies on movement on the ground and is thus vulnerable to isolation of subpopulations and landscape configuration in general.

Here, we present an ABM that incorporates population dynamics of *C. auratus*. Designed as a spatially explicit landscape model, that can load real landscape or simulated data, it provides a tool to assess scenarios of landscape composition, configuration and field management. The model incorporates temporal aspects of field management (i.e. ploughing, mowing and pesticides), but also the connectivity of habitats, barriers and agri-environmental schemes. Within a submodel, it also provides the option to assess population genetical research questions. Thus, the model is a tool for basic research questions, but is predominantly meant as tool for applied questions, such as where and how many agri-environmental schemes are needed to provide sufficient habitat at minimal costs.

20-P-04 - Modeling hoverfly populations in landscapes with a new developed agent-based model

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Due to the decline of insect biomass and species diversity in agricultural landscapes, it is important to understand how the landscape configuration and composition affect insect populations. Landscape models are one method to achieve this. For hoverflies, a model which considers different food resources is missing. Like bees (Apidae), hoverflies feed on pollen and nectar, but the larvae of many species predate on aphids. Further, hoverflies have no nests and many are highly mobile in comparison to bees. Hence, they may respond differently to landscape configuration and composition.
We developed an agent-based model for the aphidophagous hoverfly *Episyrphus balteatus*, to examine the effects of the landscape on population dynamics. To enable fast computation of juvenile and adult behavior on a daily basis over many years, the landscape was simplified to resource patches. As resource, we used realistic lists of plant species, which are spending nectar and pollen, for each land-cover type on a phenological basis.
The overall goal of the hoverfly model is to understand how landscape configuration and composition affect the population development of aphidophagous hoverflies in agricultural landscapes. In particular, we would like to test the effects of landscape heterogeneity.

20-P-05 - Unravelling the structural uncertainties of bark beetle damage predictions in models of forest landscape dynamics

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Forest are key ecosystems that provide fundamental products and services to society. Forest dynamics and capacity to provide ecosystem services are greatly influenced by natural disturbances as they often change forest functioning, structure and composition. Models of forest landscape dynamics are widespread tools to better understand forest changes and to make future predictions. These predictions are of high societal significance, stressing the importance of understanding the models' associated uncertainty. The uncertainty of the inputs, i.e. emission and climate scenarios, has received a lot of attention, but model-internal uncertainties remain under-explored.

Models of forest dynamics have complex structures as they define multiple ecological processes at different levels that are often interlinked. The selection of how to formulate each of these processes gives rise to uncertainty of model predictions, as each of them can be defined in multiple ways. It is quite difficult to assess the general behaviour of each individual model and the uncertainty linked to its predictions. However, an incomplete assessment of model-internal uncertainties implies that the evidence from model-based simulation studies is afflicted with the inherent risk of a false safety, and hence they may be of little use for supporting evidence-based management decisions.

The overall objective of this study is to assess the model structural uncertainty in landscape level processes, focusing on bark beetle (*Ips typographus*) disturbance predictions and its interactions with windthrow and drought. We are looking at the model uncertainty using the spatially explicit, process-based landscape model LandClim. The Pattern-Oriented Modelling framework is applied to decode the internal organization of the bark beetle submodel. The expected findings will strongly improve the robustness of forest dynamics models in terms of being more structurally realistic. They will also help to identify the importance of certain ecological processes and select alternative formulations for long term forest dynamics considering the impact of beetle disturbances. We are further expecting to provide robust projections of future climate impacts in forest dynamics with the consideration natural disturbances and forest dynamics.

SESSION 21

Inter- and Intraspecific Trait Variability in Plants

CHAIRS: ***Solveig Franziska Bucher, Sergey Rosbakh, Niek Scheepens***

Environmental factors such as temperature, precipitation and land use impose strong pressures on plant communities. Plants respond to changes in environmental conditions either via phenotypic plasticity or genetic adaptation or migration to follow conditions to which they are already adapted to, the last aspect leading to changes in plant community composition. All these plant responses affect trait variability, whether this be at inter- or intraspecific levels. Moreover, trait variability may vary at different spatial scales and this in turn may influence functional properties at the level of local plant communities up to whole ecosystems. In contrast to interspecific trait variability, intraspecific trait variability has been a neglected factor in community ecology for a long time and only recently there has been an interest in this source of variability to improve understanding of ecosystem functions and community processes. This resulted in the insight that considering both inter- and intraspecific trait variability simultaneously increase our understanding of ecological processes and community assembly, as both types of data can help explain niche differentiation and/or the coexistence of species. Given ongoing global change, it is important more than ever to study these distinct levels of variation to forecast plant species and community responses under further changes. This session offers a stage for scientists working on inter- or intraspecific trait variability in plants, its response to environmental changes, and its effects on higher-level processes. The presented research can address these topics through basic or applied questions in plant population ecology, community ecology and related disciplines.

21-O-01 - Evaluating drought response strategies in winter annuals: a multi-trait approach

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Understanding the mechanisms underlying species' drought responses is crucial to assess plant community responses to drought. Winter annual species escape seasonal drought by their specific life history associated with early flowering and pronounced seed dormancy. Yet, drought response strategies at the plant level, such as tolerance to maintain function under drought or avoidance to reduce desiccation, might also be relevant for annuals. Although winter annuals are a dominant life form in drylands, the traits underlying their drought response strategies and their relevance for species' performance responses to drought and ecological filtering remain understudied.

To understand drought response strategies in winter annuals, we measured 21 traits assumed to influence species' drought responses in 29 species from Israel. We linked species' trait combinations to their fecundity responses to an experimental drought and to their distribution along a rainfall gradient.

The study species exhibited trait combinations consistent with the tolerance and avoidance strategy, whereas the escape trait coordinations differed from the expected strategy. Avoidance and tolerance traits were traded-off, but both were independent from escape traits. Species with fecundity losses under experimental drought showed escape traits associated with low resource storage ability. Nevertheless, annuals with pronounced escape traits occurred across the whole rainfall gradient, likely since they evade both drought and competition. In contrast, annuals with pronounced avoidance and tolerance traits maintained similar fecundity under drought, but species with pronounced avoidance traits were favoured under moister conditions.

We showed that winter annuals exhibit a wide array of drought response trait combinations relevant for their fecundity responses to drought and ecological filtering. Our findings caution to consider them as a homogeneous group in predictions of community responses to drought.

21-O-02 - Fertilization and drought: Is species drought resistance affected by trait plasticity in response to nutrients?

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Water and soil nutrient availability are two main factors shaping grasslands. Droughts are expected to increase in frequency and severity and nutrient availability directly through fertilization or atmospheric nitrogen deposition in grasslands. However, we lack a thorough understanding of how trait plasticity in response to nutrients impacts grassland responses to drought.

We experimentally examined the plasticity of 21 functional traits hypothesized to be relevant for plant drought performance in response to 3 different nutrient conditions (nitrogen addition [N], phosphorus addition [P] and combination of NP) in 13 common temperate grassland species. We linked traits and their plasticity to species performance in a nutrient-drought mesocosm experiment.

All traits exhibited significant plasticity in response to nutrients. However, the direction and strength of trait responses varied widely across species and nutrients, and surprisingly, trait changes were mostly not consistent with our *a priori* expectations. For example, a trait combination associated with high water uptake but ineffective avoidance of low water potentials was related to high whole plant drought resistance (i.e. species' ability to maintain growth under drought). Coordinated trait shifts towards higher water uptake with nutrient addition explained species drought resilience (i.e. species' capacity to minimize long term biomass loss).

Our results indicate that the extend and plasticity of traits considered relevant under global change varies widely across species, cautions against generalizations, and highlights the need for a deeper mechanistic understanding to predict species' response to multiple global change drivers.

21-O-03 - Rising CO_2 concentrations reduce nitrogen availability in alpine grasslands

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Alpine grasslands, local biodiversity hotspots with very high nature conservation and cultural value, belong to one of the most affected ecosystems by global change. Yet, the potential effects of others than global warming factors on alpine plant functioning are poorly understood. To address this gap, we made use of 359 herbarium specimens from nine vascular plant species collected in the Bavarian Alps, Germany, extending back 200 years (1807-2018) to reconstruct historical changes in foliar N content and stable isotope composition (δ^{15}N), indicators of plant response to long-term N atmospheric deposition and rising atmospheric CO_2 concentrations ([CO_2]). These changes were interpreted in terms of three competing hypothesis (eutrophication, oligotrophication and photorespiration), representing alternative explanations for the response of plants to changes of N and CO_2 availability.
Foliar δ^{15}N decreased significantly over time but an explanation by an increased input of reactive N from long-distance transport ('eutrophication' hypothesis) was unlikely because foliar N contents decreased significantly as well. An increased carbon gain due to increasing [CO_2] ('oligotrophication') also was unlikely because instantaneous water use efficiency remained unchanged and indicated no increase in C gain. The detected patterns agreed well with the 'photorespiration' hypothesis that biochemically links N assimilation and C assimilation. Increasing concentration of ambient CO_2 that decreases photorespiration explained decreasing δ^{15}N values ($R^2 = 0.84$, $p < 0.001$) and decreasing N contents ($R^2 = 0.40$, $p < 0.036$).
Our results suggest that increasing [CO_2] by suppressing photorespiration reduces N availability to alpine plants. These findings contradict the generally accepted assumption of negative effects of eutrophication on alpine grasslands caused by air-borne N deposition.

21-O-04 - Biological traits explain deadwood bryophyte species responses to national climate and forestry scenarios in Sweden: winners are large competitors, and losers are small, short-lived species

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Forest ecosystems have been subjected to intensive exploitation, and on top of these land use driven habitat alterations, there is an ongoing and rapid climate change. Deadwood bryophyte communities are composed of species with different functional traits and affected by these processes. Understanding how species responses are mediated by traits is crucial for predicting the complex effects of global change on forest biodiversity.
We tested for differences in projected trends among deadwood bryophyte species with contrasting traits under varying climate and forest scenarios throughout Sweden during years 2020-2100. Projections were based on ensembles of species distribution models for 23 species, climate scenarios and national scenarios of forest management and conservation.
We project clear future changes in species composition. Shoot-length best explained projected future changes in species' habitat suitability. Habitat suitabilities for small, short-lived species will decline in a warmer and wetter macroclimate, whereas those for large, perennial species with high competitive abilities will increase. We predict stronger habitat decreases for obligate than for facultative deadwood species.
Increasing the proportion of set-aside forests from 16% to 32%, and reducing harvest levels in production forests from 100% to 90%, mitigated negative habitat trends of many, but not all, sensitive species. However, the potential benefits of increased conservation were even larger for species with traits favored by climate change, suggesting that these actions may also enhance the spread of increasing and competitive superior species.
Global warming is expected to lead to shifts of bryophyte communities towards large, competitive species, and to an overall decrease in diversity. A high investment in conservation actions acknowledging climate change seems necessary to maintain diversity. This should include both increasing the area of forest set-aside beyond 16%, and reducing harvest levels in production forests. However, whereas these actions may prevent species extinctions, at least in the short term, changes in community structure seem to be inevitable.

21-O-05 - Predictions of biodiversity are improved by integrating trait-based competition with abiotic filtering

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All organisms must simultaneously tolerate the environment and access limiting resources if they are to persist. Otherwise they go extinct. Approaches to understanding environmental tolerance and resource competition have generally been developed independently. Consequently, integrating the factors that determine abiotic tolerance with those that affect competitive interactions to model species abundances and community structure remains an unresolved challenge. This is likely the reason why current models of community assembly do not accurately predict species abundances and dynamics. Here, we introduce Banquo, a new synthetic framework that models both abiotic tolerance and biotic competition by using functional traits.
First, our framework estimates species carrying capacities that vary along abiotic gradients based on whether the phenotype tolerates the local environment. Second, following classical coexistence theory, it estimates pairwise competitive interactions as a function of multidimensional trait differences between species and determines which trait combinations produce the most competitive phenotypes. We demonstrate that our combined approach more than doubles the explained variance of species covers in a wetland community compared to the model of abiotic tolerances alone. Trait-based integration of competitive interactions and abiotic filtering improves our ability to predict species abundances across space, bringing us closer to more accurate predictions of community structure in a changing world.

21-O-06 - Responses of functional diversity in forest understory to resource heterogeneity

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In plant communities, species can be arranged in a multidimensional space of their functional traits. Shifts in the environmental conditions to which a community is exposed, might also entail shifts in the shape of the functional space, due to extinction or colonization of species, or plasticity in traits. Habitat heterogeneity can lead to such spatiotemporal changes in resource availability, which thus influences functional diversity, and ultimately biodiversity. Forest management, for example, is one factor introducing heterogeneity in a plant community's environment. However, little is known about the influence of structural heterogeneity in forests on the functional diversity of the understory. Therefore, we hypothesize that functional diversity of the forest understory is higher in structurally rich environments with a high degree of variability in resources, including light and nutrient availability.

We will present results from our study that combines vegetation surveys and in-field measures of resource heterogeneity from the Black Forest, Germany, with functional trait values form the TRY database.

The project aims to provide evidence-based recommendations for forest management and conservation, in order to deal with the challenges of improving and maintaining biodiversity in managed forests in Central Europe.

21-O-07 - Colour lightness as a measure to predict the response of moths to environmental change – chance and challenges

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Previous studies suggested that colour lightness is a valuable functional trait to predict the response of insects to changes in the thermal environment, as dark colouration increases the absorption of solar radiation and thus extents the activity period in cold environments, whereas it could lead to overheating in warm environments. The finding of a latitudinal gradient in the colour lightness of nocturnal geometrid moths supports the view that this trait plays a role in the distribution of species, but also challenges the underlying functional principles. Here, we present two case studies in which we examine whether colour lightness affects occurrence and abundance of moths across space, time and families. We show that darker coloured species declined more rapidly in the last decades than light coloured ones on the regional scale, which underlines the potential of colour lightness as a functional trait to predict the effect of global warming on insects. However, divergent trait–environment relationships between moth families on a local scale highlight the gaps in the understanding of the underlying mechanism of this relationship, which cautions against the use of colour lightness as a sole predictor.

21-O-08 - Phenological responses and the impact of temperature on winter leaf production in European woodland strawberry (*Fragaria vesca*) genotypes

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According to the climate model, long and warm autumns, and mild periods in the winter with less snow will become more common in the Northern Hemisphere. In studies concerning the impact of climate change on plant species, it has been noted that the elevated temperature prolongs growth season, which in turn affects the phenology of plants and the annual preparation for overwintering. Woodland strawberry (*Fragaria vesca*) has a large geographical range, hence great ability to adapt to different climates. *F. vesca* has two seasonal leaf types – separate summer and winter leaves, therefore, the phenology and photosynthetic activity of the leaves are adapted to the season and the prevailing conditions. Ten woodland strawberry genotypes originating from several latitudes in Europe was used in this study to investigate their phenological responses when translocated to a new climate (Finland), and to examine the impact of temperature and daylength on winter leaf production. The results show that the temperature has a major impact on the winter leaf production in the autumn. However, the genotypes displayed traits of adaptation to different climates and winter leaf phenology indicting a latitude-based pattern, therefore the adaptation and genetic background affect the responses, despite the prevailing environmental conditions. A detailed understanding of phenotypic plasticity is essential for the assessment of adaptation to different climates. Furthermore, the knowledge will contribute to deeper understanding of evolutionary processes, adaptation ability to different climates and the effects of climate change on closely related species.

21-O-09 - The PhenObs initiative - Linking plant phenology to functional traits in herbaceous species in Botanical Gardens

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In the PhenObs Network scientists from 20 Botanical Gardens work together to monitor the weekly phenology of herbaceous plants to show variations on a regional and global scale. Botanical Gardens are a proper location for studies of phenology and plant functional traits: In this controlled setting we find a lot of different species from different habitats under similar and controlled site conditions (like climate or soil) and can therefore take into account intraspecific trait variations. Changes in phenology are the fingerprint of climate change. Nevertheless, studies monitoring the entire life cycle, especially of herbaceous plants, are rare. To assess whether different plant characteristics determine specific responses in phenology, we monitored phenology following standardized protocols in 260 herbaceous species in six Central European Botanical Gardens in the years 2019 and 2020. We recorded duration and intensity of vegetative (leaf out, senescence) and generative (flowering, fruiting) phenology. On the same populations and in each Botanical Garden, we measured traits being associated with (1) productivity and competitive ability (plant height, absolute and specific leaf area, leaf dry matter content [LDMC], leaf carbon [C] and leaf nitrogen [N] content, and C/N ratio) and (2) dispersal and regeneration (seed mass). We found taller species to start flowering later than shorter ones, whereas earlier flowering was associated with higher seed mass. High N content was related to earlier senescence, while high LDMC values were related to later senescence and longer growing season length. For the majority of tested relationships, the associations between phenology and traits differed between the gardens. Our results propose that functional traits have a high potential in explaining phenological variations and we therefore propose to include functional traits in future analyses on climate change effects.

21-O-10 - Pollinator community predicts trait-matching between spurs of oil-producing flowers and forelegs of a guild of oil-collecting bees

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The fascinating pollination system of oil-secreting *Diascia* flowers and oil-collecting *Rediviva* bees is associated with high levels of inter- and intraspecific trait variability. Many *Diascia* species reward their pollinators with floral oil secreted in cells (elaiophores) located in dorsal floral twin-pouches that have evolved into spurs of various lengths, including extreme elongation in some species. *Rediviva* females collect floral oil with modified pilosity of their foretarsi to mix with pollen for nest provisioning or lining brood cells. Females of some *Rediviva* species have evolved elongated forelegs to reach oil in long-spurred host plants. Combinations of spur- and leg-lengths result in a geographically variable pattern of trait-matching. Most studies that quantify trait-matching focus on exclusive pairwise species interactions, even though many mutualisms involve multiple interaction partners. Therefore, we investigated ten communities in which one to three *Rediviva* species pollinate the long-spurred flowers of *Diascia 'floribunda'* to examine how pollinator diversity affects covariation of functional traits across sites and trait-matching within sites. The mean spur length of *D. 'floribunda'* and mean foreleg length of *Rediviva* bees varied significantly across sites. Correlations between floral spur-length and bee foreleg-length among sites in the *Rediviva*-*Diascia* pollination system are significant at the pollinator community level but not at the level of individual pollinator species. The closeness of trait-matching varied among populations and was inversely related to pollinator community diversity. For all bee species, trait-matching was closest at sites characterized by exclusive, pairwise interactions. Reduced trait-matching associated with increased community diversity for individual pollinator species, but close matching at the community level support the importance of community context for shaping interacting traits of flowers and pollinators.

21-O-11 - Effect of drought and competition on cleistogamy-phenotypic plasticity and developmental constraints

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Cleistogamous plants produce closed, obligately selfing flowers. Most cleistogamous species also produce open, potentially outcrossing flowers in variable proportions. Thus, cleistogamy is a plastic, putatively mixed-mating system. Various explanations have been proposed for the maintenance of plastic cleistogamy – avoidance of the negative consequences of selfing (inbreeding depression, geitonogamy) or adaptation to environmental factors (pollinator abundance, resource availability, differential dispersal strategies). Each of these explanations has been tested independently from the others. We hypothesize that adjustments in the proportion of closed flowers can be simultaneously an adaptation to multiple environmental pressures each favoring different reproductive strategies. To test this, we subjected seven populations of an annual cleistogamous species, *Lamium amplexicaule*, to a full factorial experimental design combining competition (biotic) and drought (abiotic) stress in two seasons. We show that plants exposed to competition and/or drought are smaller. The proportion of closed flowers increases when plants suffer both competition and drought, but not in competition or drought alone. Even more surprisingly, the seed production of closed flowers, which are considered a more reliable means of reproduction than open flowers, decreases in response to competition and drought stress. Reproductive output of closed flowers varies across environments. We explain these results as independent adaptive response to two environmental stresses – increasing the production of open flowers production when grown in competition potentially increases the proportion of outcrossed offspring that do not suffer inbreeding depression, and thus compensates the reduced number of offsprings by increasing its quality. However, this is only possible if the plant has enough resources (water) to invest in the production of costly, open flowers. These results show that plastic cleistogamy cannot be viewed as solely a mixed-mating strategy aiming to avoid genetic consequences of inbreeding, nor as floral dimorphism that is an adaptation to environmental variation, but rather a combination of both.

21-O-12 - Ecology insight to the seed nutrient composition

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Maternal care is one of the key components of fitness in all organisms. The magnitude of maternal care is driven by the evolutionary optimization by mortality patterns of offspring, and therefore it is often fine-tuned to the expected environment where the offspring develop. In plants, the key component of the maternal care is the provision of the offspring by resources in the seed and is primarily determined by the seed mass.
However, seed mass is not the only determinant of maternal care. Content of major nutrient components such as nonstructural carbon, nitrogen and phosphorus in seeds exhibits enormous variation across species. C:N:P stoichiometry of seeds should thus be viewed as part of the C:N:P stoichiometry limitations which is one of the key drivers of organism mineral balance and of ecosystem dynamics. It constrains photosynthesis and growth, affects seedling development and drives patterns of herbivory both in water and terrestrial habitats.
Patterns of seed traits show convincingly that evolution of seed has been strongly shaped by environmental conditions where the plants occur. This should concern nutrient stoichiometry as well, as an emerging seedling may encounter very different conditions and hence very different resource limitations: in shaded conditions, it will experience carbon limitation, whereas nutrient-poor conditions will result into nitrogen or phosphorus limitation. It is likely that the chance of the emerging seedling to survive under conditions with a particular limiting nutrient will be boosted if the seed has abundant provision of that nutrient. Good provision of seeds with nutrients that are limiting may hence strongly contribute to their survival.
Therefore, we measured amount of nitrogen, phosphorus and nonstructural carbon in seeds of 510 species. We assembled information on nutrient and light availability of their typical habitats to approximate the likely environmental limitation experienced by their seedlings. Linking these two data sets provided to test the hypothesized relationship between nutrient stoichiometry and expected environmental conditions of the seedling. As both seed nutrient stoichiometry and seed mass are known to be phylogenetically constrained, we also examined the phylogenetic component in their variation, and determined their relationship also taking the phylogenetic constraints into account.

21-O-13 - Seed dispersal by wind decreases when plants are water-stressed, potentially counteracting species coexistence and niche evolution

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Hydrology is a major environmental factor determining plant fitness, and hydrological niche segregation (HNS) has been widely used to explain species coexistence. Nevertheless, the distribution of plant species along hydrological gradients does not only depend on their hydrological niches but also on their seed dispersal, with dispersal either weakening or reinforcing the effects of HNS on coexistence. However, it is poorly understood how seed dispersal responds to hydrological conditions. To close this gap, we conducted a common-garden experiment exposing five wind-dispersed plant species (*Bellis perennis*, *Chenopodium album*, *Crepis sancta*, *Hypochaeris glabra*, and *H. radicata*) to different hydrological conditions. We quantified the effects of hydrological conditions on seed production and dispersal traits, and simulated seed dispersal distances with a mechanistic dispersal model. We found species-specific responses of seed production, seed dispersal traits, and predicted dispersal distances to hydrological conditions. Despite these species-specific responses, there was a general positive relationship between seed production and dispersal distance: plants growing in favourable hydrological conditions not only produce more seeds but also disperse them over longer distances. This arises mostly because plants growing in favourable environments grow taller and thus disperse their seeds over longer distances. We postulate that the positive relationship between seed production and dispersal may reduce the concentration of each species to the environments favourable for it, thus counteracting species coexistence. Moreover, the resulting asymmetrical gene flow from favourable to stressful habitats may slow down the microevolution of hydrological niches, causing evolutionary niche conservatism. Accounting for context-dependent seed dispersal should thus improve ecological and evolutionary models for the spatial dynamics of plant populations and communities.

21-O-14 - A novel and universal method for improved measurement of seed terminal velocity

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Seed terminal velocity (Vt), the maximum falling speed of a seed in still air, is the most important seed trait affecting dispersal by wind, one of the dominant seed dispersal mechanisms. It is vital to accurately measure seed Vt not only for predicting seed dispersal distance but also for understanding intraspecific or within-individual variation in seed dispersal ability in various environmental contexts. However, to some extent all previous methods fail to accurately measure Vt of single very slow- or fast-falling seeds, falling seeds that are still accelerating, fragile seeds, or seeds with complex structure or complex falling trajectories. We present a video-based method with a novel design including a mirror that enables observations from two perspectives, which in turn allows unbiased determination of seed locations in 3D space for all seed types. We calculate Vt by fitting a mechanistic acceleration model to these locations over time describing the process of the falling seed based on laws of physics. We compare our results with corresponding Vt values from LEDA database and to own measurements of a subset of the same seeds performed in a vertical wind tunnel. We also measured spherical balls for which theoretical values can be calculated with physical equations. Our measured Vt values of seeds are markedly higher than those in LEDA database, especially for fast-falling seeds, demonstrating that most previous methods do not consider acceleration of seeds and hence underestimate Vt. Close agreement of measured Vt values and wind tunnel results for seeds as well as theoretical results for spheres strongly raises confidence in our method. By determining the true 3D locations of falling seeds at high temporal resolution, our method can, moreover, inform the study of complex falling trajectories of seeds and their ecological implications. Being time efficient, non-destructive, and applicable to measure Vt accurately for any relevant seed type, our method will help to improve the existing data basis on Vt, quantitatively and qualitatively, and hence will considerably benefit the field of seed dispersal ecology.

21-O-15 - Adaptation of the hemiparasitic plant *Rhinanthus alectorolophus* to its potential host plant *Plantago lanceolata*

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Root hemiparasitic plants attach to the roots of their host plants with specialized organs (haustoria) to withdraw water, nutrients and carbohydrates. So far, only little is known about the degree of coadaptation of parasites and their hosts. Native root hemiparasites are usually regarded as generalists, because they can grow with a wide range of host species. However, plant species differ in their quality as hosts judged by their effects on parasite biomass. Some host species (e.g. *Plantago lanceolata*) are even known to defend themselves against parasite attack by blocking the haustoria of the parasites. We hypothesize that coadaptation is most likely to be found in interactions with host species capable of a defense against parasite attack as the result of an arms race. We thus grew seedlings of the hemiparasite *Rhinanthus alectorolophus* from eight sites across Germany with *Plantago lanceolata* from all those sites as a host in a factorial design. Overall, *P. lanceolata* was a poor host and the parasites stayed very small. However, *R. alectorolophus* grew consistently larger when grown with sympatric hosts from its population of origin than with hosts from other (allopatric) populations, suggesting some adaptation of the parasites to local host populations.

21-P-01 - Comparison of phenological and growth traits between native, invasive and naturalized populations of *Bunias orientalis*

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When plants expand their distribution range, they may be confronted with environmental conditions that differ from those at the native origin. As a result, plants growing in the new habitat may show certain shifts in some traits but other traits may remain unmodified. We compared various phenological and growth traits of twelve populations with different ecological status (native, naturalized or invasive) of the intracontinental range-expander plant species *Bunias orientalis* when grown under common garden conditions. There were no differences in delay until bolting, flowering and fruiting between plants of different ecological status, with many plants of the native populations not starting to flower at all, regardless of a vernalization period. Long-term adjustments to low annual temperatures at the origin of these native populations may explain this phenology. The total number of leaves differed significantly between plants of different ecological status. Plants of the invasive populations had the highest number of leaves, highlighting their ability to accumulate more plant biomass. Several other growth and reproductive traits differed significantly among populations independent of their status. This finding may be explained by the fact that *B. orientalis* experienced multiple introduction events and shows a high genetic diversity. Overall, long-term adaptation to conditions at the habitat of origin as well as short-term adaptation to novel environments lead to trait differentiation and thus high intraspecific variation.

SESSION 22

Biotic Interactions of Trees and Their Associated Microbial Species Under Global and Climate Change

CHAIRS: ***Katharina Budde, Kathrin Blumenstein***

Biotic interactions of tree species with pathogens (fungi, bacteria, viruses and other microorganisms), endophytes (fungal or bacterial) or ectomycorrhizal communities play an important role in forest ecosystems. They affect the physiology and vitality of keystone forest tree species and thereby shape the population structure, species composition and dynamics of ecosystem processes. These interactions are important components in natural ecosystems, where the different species coevolved. In the course of climate change and globalization, the species distribution areas of tree associated organisms are shifting. Species that originally only occur locally may get spread worldwide by humans, through global trade and transport, and are sometimes able to find new host tree species. In the case of pathogens and due to the lack of coevolution in the new range, the host populations often show low resistance and get rapidly infected. Well-known examples in Europe are Dutch Elm Disease, and Chestnut Blight which have caused great ecological and economic damage. Most recent invasive fungal pathogens are responsible for causing e.g. Ash dieback or Sooty Bark Disease and are serious threats to European Ash and Maple species. Additionally, weakened host trees suffering from changes in abiotic conditions show higher susceptibility to common pathogens, e.g. to *Heterobasidion* spp. causing Root Rot in conifers. Under certain conditions in a weakened host also a switch from opportunistic endophytes to pathogens can be triggered. This is currently observed e.g. in *Sphaeropsis sapinea* (syn. *Diplodia sapinea*) causing Diplodia Tip Blight on conifers, especially pine species. However, other tree-fungus interactions are beneficial for both interacting partners, such as trees and their associated ectomycorrhizal, soil or phyllosphere endophytic communities, which can improve host resistance to drought. In this session, we would like to focus on changes in biotic interactions in forest ecosystems and particularly welcome presentations that aim at understanding factors that determine 1) the pathogenicity or virulence of pathogens, 2) resistance mechanisms in hosts, 3) the effect of changing environmental conditions in relation to putative adaptations of the host, as well as 4) beneficial interactions with other microorganisms (e.g. micro- and mycobiomes).

22-O-01 - Barriers, carriers and corridors – relevance of forest spatial arrangements for tree-pathogenic fungi

***Johanna Witzell*[1]**

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In forests, the spread of pathogenic fungi and development of disease epidemics is highly dependent on the spatial arrangement of susceptible host trees. Structural characters of the forests, such as the tree species composition and the spatial grain of mixtures at the level of stands and landscapes are therefore important features to consider when designing resilient forests for future climate. The landscape level connection between woodlands and urban green areas is another aspect to think about, because introduction of alien invasive species to forests may readily occur via urban settings. Adaptation to climate change and mitigation of its effects on the multiple ecosystem services necessitate revision of current forest management practices. For instance, mixed forests with different spatial grains may be increasingly preferred over monocultures. There is also an increasing interest in diversifying the palette of tree species used in forest regeneration, and responding to the changing climate with assisted migration of tree species. All these measures will influence the trajectory of tree-pathogen interactions. In this presentation, the potential consequences of different forest management regimes for the tree-associated microbes are discussed, considering the impacts of spatial arrangements for the built up of the inoculum, spread of the propagules, and tree resistance.

22-O-02 - Factors influencing community composition of fungal and bacterial microbiome in Scots pine seedlings (*Pinus sylvestris* L.) in Southern Sweden.

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The capacity of forest trees to provide different ecosystem services is closely linked to the biodiversity that they harbour. Microbiome is an important part of this biodiversity, but especially the fungal and bacterial diversity in above-ground parts of forest trees is still poorly studied. In the present study we describe the taxonomic diversity of fungi and bacteria from 41 Scots pine seedlings (2-year-old) sampled at 3 different locations in Southern Sweden. The samples included seedlings showing several symptoms of growth disturbances such as absence of terminal guide, multiple leader shoots, and proleptic shoots, as well as symptomless plants. We studied the fungal and bacterial communities through a meta-genomic approach with the Illumina platform. A total of 878 operative taxonomic units (OTU) of fungi and 573 OTUs of bacteria were found. The community composition varied significantly between the sampling locations and among the different symptoms observed but not between the symptomatic and the asymptomatic seedlings. The results suggest that even young, planted seedlings are of great value as a habitat for microbial diversity and that location is a key factor in the assembly of the bacterial community.

22-O-03 - Latent fungal pathogens associated with woody tissues of European beech and their impact on tree health

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European beech (*Fagus sylvatica* L.) is one of the major tree species in Central Europe. Even though it has a wide climatic and geological amplitude, as well as high shade tolerance and growth capacity, European beech stands face loss of vitality due to ongoing climate change. The extraordinary weather conditions in the years 2018 to 2020, including prolonged periods of high temperature, droughts and high levels of solar radiation increased the predisposition of European beech to fungal infection, beetle attacks, and triggered sunburn and the outbreak of complex diseases mainly caused by latent fungal pathogens. Loss of vitality and mortality of European beech have been observed and studied in several regions of Germany. In these studies, a number of fungi associated with woody tissues of European beech were identified or isolated. The virulence and pathogenicity of twelve ascomycetous strains which were known to be endophytes, associated with bark necroses, or associated vitality loss of European beech (VLB) were studied in inoculation tests with potted beech saplings. These fungi, including species of Botryosphaeriales, Hypocreales, and Xylariales were examined to shed light on the beech endophyte community and examine the impact on tree health. The aims of this study were (1) to confirm the pathogenicity and virulence in planta of latent fungal pathogens originally associated with bark necrosis or VLB, (2) to test virulence of the fungal species under field conditions with vital trees without drought stress, (3) to reveal whether there are influences between beech stem endophytes and the inoculated pathogens. Except from *Neonectria ditissima,* all fungal strains used in our pathogenicity tests could be re-isolated, indicating successful infection by these strains and establishment in the woody tissue. During the inoculation experiment in planta, *Botryosphaeria corticola* caused the longest necrotic lesions in *F. sylvatica* saplings but did not kill the plants within four months.

22-O-04 - Mycobiome composition of Norway spruce stems and roots is influenced by genotype after artificial inoculation with *Heterobasidion parviporum*

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Forests are dealing with increasing stress due to challenges been posed to them such as the effects of climate change and pathogens. Norway spruce is one of the most economically important tree species in Europe and highly susceptible to attacks from the *Heterobasidion annosum* species complex. The losses are estimated to be around 800 million € yearly in Europe. The plant mycobiome plays a crucial role in the maintenance of its ecological health and the diversity of the fungal composition is vital in predicting the growth and survival of plants against pathogens. As chemical plant protection is aimed to be replaced with more green options and mycobiome can increase tree fitness, it is important to understand these relationships between plants and microbes. We investigated the possible differences in the mycobiome between four genotypes of three-year-old *Picea abies* saplings under normal water supply and drought stress conditions in a greenhouse setting. 50% of the trees were artificially inoculated with *Heterobasidion parviporum*. Total RNA and genomic DNA were co-extracted from the stems and roots of the pre-selected saplings and the genomic DNA was sequenced using the ITS2 high throughput sequencing (HTS) technology. The analysed samples were manually identified to species level. Our preliminary results show differences between the mycobiome of Norway spruce due to the genotype. The novel knowledge gained in this study could be ultimately used to improve forest resilience.

22-O-05 - Adding causality to correlations: Validation of predictive models in lab experiments on plant-microbe interaction in an alpine succession

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Successional chronosequences represent environmental gradients that host diverse communities where plants and microbes co-occur and interact. In a combination of field investigations and lab experiments, hypothesis generated can be tested in experimental conditions to verify correlative findings from field data to infer causality. Recently deglaciated forefields that create virtually uninhabited substrates waiting for initial colonization of bacteria, fungi and plants provide a great successional system for studying the transformations in community composition and diversity over time and the interactions between biotic groups. In this study, 135 permanent plots were established in the forefield of the Austrian glacier Ödenwinkelkees and the plant and microbial communities along the successional gradient were investigated. Mutual predictability between plant and microbial communities was detected with machine learning algorithms. To verify these findings in the lab, we established a microcosm experiment with soil taken from our study plots and seeds of plant species collected in the field. Plant communities in the microcosms differed in (functional) diversity and the proportion of a single plant species, *Campanula scheuchzeri*, which serves as a focal species in our project. After four months of growing, we measured the biomass of plants and took soil microbiome samples for sequencing and the measurements of functional diversity of microbial communities. The results showed a shift of functional diversities from the beginning to the end of the experiment and between treatments for microbial communities. These results provide experimental verification of plant's effect on modifying microbial communities and validate the use of predictive models in exploring ecological patterns.

22-O-06 - Microbial community structure in ash with special focus on *Fraxinus excelsior* and ash dieback

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The forest tree microbiome is receiving growing attention because of its potential as a key component in forest health and ecosystem functioning. It has been shown that microbial composition of forest tree species stressed by pathogenic diseases can differ between healthy and unhealthy trees. In Europe, the native common ash (*Fraxinus excelsior*) is threatened by an invasive Ascomycete fungus *Hymenoscyphus fraxineus* but there is significant variation in susceptibility among clones of common ash. Susceptibility also differs among species. We hypothesized that clones of *F. excelsior* and *Fraxinus* species accommodate distinct fungal communities that play a role in ash dieback tolerance. Through a conventional approach, we found that fungi in the orders Pleosporales and Hypocreales (e.g. *Boeremia exigua* and *Diaporthe* spp.) were common taxa in five ash dieback-resistant *Fraxinus* species (*F. lanuginosa*, *F. pennsylvanica*, *F. ornus*, *F. chinensis* subsp. *rhynchophylla* and *F. mandshurica*) and in an *in vitro* test a number of the endophytic species exhibited high antagonistic activity against *H. fraxineus*. Similar to the conventional approach, an ITS1-metabarcoding analysis of twig mycobiomes of eight *Fraxinus* species from different evolutionary clades (Fraxinus, Ornus and Melioides) and clones of *F. excelsior* confirmed the results from the conventional approach, in which fungi in the classes Eurotiomycetes and Dothideomycetes were among the prevalent taxa. The study also revealed significant differences in diversity and composition of the fungal twig community among the analyzed species of *Fraxinus*. While fungal community differed also among *F. excelsior* clones with differences in ash dieback susceptibility, further information is needed to understand the potential association to *H. fraxineus.* A new experiment has been initiated with the aim to explore the maternal effect on bacterial and fungal community of *F. excelsior* half-sibs grown at two different sites.

22-O-07 - Genome wide association studies explore the genetic basis of resistance to ash dieback fungus in *Fraxinus excelsior*

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Since the 1990s, the widely distributed native European ash (*Fraxinus excelsior*) has been devastated by an invasive fungal pathogen - *Hymenoscyphus fraxineus*, which causes ash dieback. *Hymenoscyphus fraxineus* is a foliar pathogen native to East Asia which is less virulent on local ash species. *Fraxinus excelsior* is a naïve host of *H. fraxineus* and is being severely damaged across the European continent. However, *F. excelsior* is affected on a scale, and previous studies have documented significant genetic variation among individuals of *F. excelsior* in disease resistance and susceptibility. Ash dieback symptoms can be visibly measured through field observations. Here, almost 500 *F. excelsior* samples from nine clonal trials in six European countries have been collected for genome association studies. This work is currently ongoing and the aim is to identify genetic loci (SNPs) associated with phenotypic variation to ash dieback.

22-O-08 - Analysing the variation in virulence of the ash dieback pathogen *Hymenoscyphus fraxineus*

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The causal agent of ash dieback, *Hymenoscyphus fraxineus* (T. Kowalski) Baral, Queloz & Hosoya*,* was first detected in Germany in 2002. The main symptoms on the European ash (*Fraxinus excelsior*) include necrotic lesions and shoot dieback that reduces tree vitality, timber quality, and can cause tree mortality. Consequently, the disease is associated with significant economic and ecological damages.

We will analyse pathogen virulence using infection studies. Initially, we will investigate the potential for rejuvenating strain collections through reintroduction to ash saplings. We will assess changes in growth rate and biomass production between strains on four media, including two amended with ash plant material. We will also evaluate changes to *in planta* symptom development to determine rejuvenation. We hypothesise that it is possible to maintain strain virulence and rejuvenate old strains through standard procedures in the laboratory and greenhouse.

We will also isolate new *H. fraxineus* strains in collaboration with project partners. We will evaluate disease development from petiole inoculations and standard stem inoculations. Petioles are considered the main infection court of the pathogen, so we hypothesise that the inoculation site could influence determination of strain virulence and assessments of ash sapling resistance. We will also attempt to establish a protocol for inoculations with ascospore suspensions.

Overall, our experiments within the FraxForFuture project will contribute further insights into the pathogen and disease development, which will inform future *in vitro* infection studies. These insights will facilitate the development of new and existing strategies for improved forest health and disease management.

22-O-09 - Heat stress affects soil fungal competition and their interaction types - a modelling approach

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Fungal communities are shaped by competition for resources, which is characterized by various antagonistic interaction types. Both the competitive outcome and the qualitative type of interaction between fungi have been show to change under periods of heat stress. However, the underlying mechanisms of how fungal heat stress defense and competition interact remain unclear.
Here, we used a partial differential equation (PDE) model to simulate two fungal colonies competing in a two-dimensional space. With this model, we determined the growth, the production and secretion of antifungal compounds and the synthesis of heat shock proteins of both interacting colonies to understand the mechanisms leading to the observed change of fungal competition under heat stress. Our approach revealed that a heat stress-induced lag phase favored the accumulation of antifungal compounds and the build-up of an inhibitor field. This can lead to qualitatively changing type of interaction and to altered competition in favor of slower growing species, as these benefit stronger from the additional time during a stress-induced lag to build up a defense or block territory. This is an important step towards understanding drivers of fungal community dynamics and how they are affected by environmental changes.

22-O-10 - When and where do the predators keep the plants flourish?

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It is well recognized that predators can enhance plant growth by reducing herbivore abundance. Yet the strength of such trophic cascades has been found to be quite variable both within and between communities. Even less is known about how climatic conditions and forest degradation affect the trophic cascades between predators and plants, and whether the cascades respond to climatic changes flexibly. We hypothesise that birds, bats and ants are important predators of arthropods, which further affect plant growth directly and indirectly and we investigate their effect on lower trophic levels in dry and wet season, and along temperature gradients as well as in primary, secondary and forest fragments which differ in microclimate. To find out where and when top-down forces control food webs, we run predator exclosure experiments, excluding ants, birds, and/or bats separately, and in combinations, from forest saplings and from branches in forest canopies. We also run smaller experiments in laboratories to identify the direct and indirect effect of predators on lower trophic levels under different climatic scenarios. We discuss that stable arthropod populations are maintained by natural enemies only under specific wet and moist conditions and disruption of communities of natural enemies often, but not always, result into significantly increased abundances of insect, increased herbivorous damage and into changes in leaf traits. We show that under specific climatic conditions, the large effect of predators affect only arthropods but doesn't cascade down to plants and this can change flexibly if the communities of predators remain relatively undisturbed.

22-P-01 - Response of soil fungal communities to site conditions and tree species composition in pure and mixed beech-conifer tree stands

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Beech and spruce forests are under pressure by climate change and calamities. Therefore, integrating alternative, potentially more stress-resistant tree species, such as Douglas-fir, into beech forests might offer new opportunities to achieve productivity and maintain ecosystem functions. However, the impact of Douglas-fir on belowground microbes, such as soil fungi, when grown outside its natural range in pure or mixed tree stands is unknown. Soil fungi mediate essential ecosystem functions, such as decomposition and nutrient cycling. The fungal community composition is affected by changes in site characteristics and vegetation. To explore the impact of enriching beech with native (spruce) and non-native (Douglas-fir) tree species on soil fungal communities along an environmental gradient (soil fertility and precipitation), we collected soil samples from pure (beech, spruce, Douglas-fir) and beech-conifer mixed stands. Soil fungal communities were determined after DNA extraction and amplification of the ITS region. We observed dissimilarity of fungal communities between nutrient-rich and -poor sites. Fungal assemblages between beech and conifers were distinct while beech-conifer mixed tree stands exhibited fungal communities intermediate between those of pure beech and conifer stands. Mycorrhizal abundance was lower in the pure Douglas-fir and beech-Douglas-fir mixture than in beech and beech-spruce stands while saprotrophic fungi were more abundant in soils of conifers. In conclusion, our results elucidate changes in fungal structures and functions in pure and mixed beech-conifer stands which can potentially influence nutrient fluxes.

22-P-02 - Impact of *Phytophthora agathidicida* infection on dissolved organic carbon and nutrient fluxes in a kauri dominated forest

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Kauri dieback, caused by *Phytophthora agathidicida*, is a recent threat to the survival of kauri (*Agathis australis*) forests in New Zealand. Pathogen-induced tree dieback and mortality may alter plant species composition and biogeochemical processes. Previous studies have shown that throughfall and stemflow play an important role in meeting the nutrient requirements of healthy kauri forests. However, the effects of kauri dieback on the amount and transfer of dissolved organic carbon (DOC) and macro- and micronutrients via water-related pathways remain unknown. To address this knowledge gap, we measured DOC, dissolved nitrogen (DN) and nutrient fluxes (potassium, calcium, magnesium, manganese, silicon, sulfur, sodium, iron) in throughfall, stemflow and forest floor solution of ten kauri trees differing in their infection level (using soil *P. agathidicida* DNA concentration as an indicator) kauri over one year.
Nutrient concentrations in throughfall and stemflow were up to 10-fold higher than nutrient concentrations in bulk precipitation. Although some infected trees showed a considerable loss of foliage, we did not observe a relationship between water flux and *P. agathidicida* infection level. Throughfall DOC, DN, and nutrients fluxes tend to decrease with increasing infection level. However, significant correlations were only found for throughfall DOC, DN, potassium, and manganese fluxes and DOC, DN, and calcium and silicon fluxes in forest floor leachate. No relationship was found between stemflow DOC, DN, and nutrient fluxes and infection level. Changes in throughfall chemistry may be related to *P. agathidicida* induced changes in leaf chemistry and leachable leaf surface area. The observed alteration in throughfall and forest floor nutrient fluxes of *P. agathidicida* infected kauri trees could lead to long-term changes in biogeochemical processes (e.g. mineralization, nutrient availability) in these ecologically unique kauri forests.

22-P-03 - Horse Chestnut (*Aesculus* spp.) trees' health status linked to variances in the assemblage of endophytic fungi

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Horse Chestnut (*Aesculus*) is a genus of common ornamental trees in western and central Europe with high biodiversity value, mainly found in urban areas, such as city parks, cemeteries and campuses in Germany. Due to increasing temperatures and a rising invasion of non-native pests and pathogens, premature leaf dieback, abscission, and intense impact on tree death have been observed especially in the last decades. Leaf miner (*Cameraria ohridella*), leaf blotch (*Guignardia aesculi*), powdery mildew (*Erysiphe flexuosa*) and bleeding canker (*Pseudomonas syringae* pathovar *aesculi*) are responsible for causing the most devastating disease symptoms. This study aimed to investigate the endophytic fungal communities of Horse Chestnut leaves, twigs, bark, and phloem tissues from *A. Hippocastanum*, *A. x carnea* and *A. flava* with varying health status, ranging from symptomless to heavily infected. Symptoms were indicated by reddish-brown spots with yellow margins, white spots or larvae tunnels on leaves, and rusty-colored or blackened bleeding cankers in the bark and twigs. The samples were collected from 108 monitored Horse Chestnuts within the city of Göttingen. Healthy and symptomatic leaves, twigs, bark, and phloem tissue samples were analyzed consecutively, followed by fungal isolation. The DNA of one representative strain of each of the ca. 80 obtained morphotype groups was extracted and identified based on the ITS4 region. A high fungal diversity of Ascomycetes could be isolated. Among typical endophytes and ubiquitous fungi such as several *Xylaria* spp., *Phomopsis* spp., *Cladosporium* sp. and e.g. *Alternaria alternata*, *A. infectoria* or *A. tenuissima*, also common tree saprobionts and potential pathogens such as *Biscogniauxia nummularia*, *Hypoxylon fragiforme*, *Diaporthe* spp., *Didymella* spp. and several *Fusarium* spp. could be isolated from the tissues. This study describes and links the health status of their host tree to the pathogen and endophyte community.

22-P-04 - Evaluation of the genotype effect to the root mycobiome of Norway spruce

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The composition of the plant mycobiome develops in respect to influences received from abiotic and biotic factors as well as host and fungal genotypes. Pinpointing the major driving forces can give insights in understanding the mycobiome establishment and further evolution. In this study, the role of host genotype and water availability in shaping Norway spruce (*Picea abies*) root mycobiome were evaluated. The roots of five genotypes and trees from two watering scenarios were sent for metagenomic sequencing of the ITS2 region and the species abundance and diversity were compared. The different genotypes in the optimal watering group displayed a significant difference in the operational taxonomic units (OTUs) obtained, while in the reduced-watering group no difference was found. The two watering scenarios showed no significant difference to the mycobiome composition, while the genotype had a major influence.

22-P-05 - Analysing gene markers of *Cryptostroma corticale* and its putative relatives

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The ascomycete *Cryptostroma corticale* (Ellis & Everhart) Gregory & Waller is the agent of sooty bark disease. It is believed to be native in North America, but is present in Europe at least since 1945. The main host in Europe is sycamore (*Acer pseudoplatanus*), but it can also affect other *Acer* spp. The fungus can, at least temporarily, live in an endophytic stage, but causes disease after warm and dry summers. In continental Europe, sooty bark disease has spread in the aftermath of the extraordinarily dry summer of 2003, and significant damage was caused in Central Europe during and after the extreme summers of 2018 and 2019. Facing climate change, an increase of the fungus' significance as a tree pathogen is to be anticipated. The fungus produces large masses of conidiospores in the phloem, which are released when the bark cracks open. A teleomorph has not yet been identified. Inhalation of larger amounts of the conidia can lead to a hypersensitivity pneumonitis in humans, and special management is required to prevent risks for human health, particularly in frequented areas.
The fungus has been placed in the genus *Biscogniauxia* (Xylariaceae) by Koukol et al. (2015), but a recent study suggests it belongs to the family Graphostromataceae (Li et al. 2021). We have planned a project in order to investigate samples of *C. corticale* and putative close relatives. Our aim is to achieve a better understanding of the pathogen's life cycle, diversity and phylogeny.

SESSION 23

EU-Living Labs in Agricultural Settings: Enabling Transformations in Agriculture Towards Sustainable Land Use and Food Systems

CHAIRS: ***Fabian Nürnberger, Maria Busse, Anett Richter***

The GFÖ in 2020 is framed under the motto "Science in Transition, Science for Transition". Science in agricultural settings is challenged by the increasing pressure to find solutions that are ecologically sensible, socially acceptable and economically profitable. Living laboratories represent a promising approach to bring science into practise and to pathway transformations. The concept of living labs is a user-driven and integrative approach, which aims at co-designing innovative solutions and collectively experimenting innovations in real life settings. It builds on collaborations between different disciplines and practitioners as it is claimed in transdisciplinary research and citizen science. Furthermore, living labs aim at creating research-implementation spaces, establishing active networks and partnerships, and enabling social learning and co-production of knowledge. While transdisciplinary research projects caught attention, and the number of living labs is increasing, there are, until today, only few experiences in establishing and managing them. Challenges are differences between stakeholders' and researchers' timelines, objectives, and capacities to collaborate. Hence, the purpose of this session is to a) bring scientists from different fields with expertise in running or conceptualizing living laboratories or related transdisciplinary research projects on sustainable land use or food systems together and to b) develop in the future guidelines on how to best establish a network of living labs in agricultural settings and beyond. In our session, researchers that have already established living labs will share their best practise examples (case studies). As a group we will identify and discuss differences and similarities of presented transdisciplinary approaches. Further, we will develop a list of challenges and will co-develop practical solutions on how to address of establishing and managing transdisciplinary research projects to transform intricate systems together with stakeholders. The session will be summarised in form of a short report and findings will inform the projects FInAL and AE4EU.

23-O-01 - Social Labs for mediating biodiversity conflicts between agricultural practice and insect decline in protected areas

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The DINA project on insect decline in nature protected areas investigates the immediate effects of agricultural practice neighboring protected areas in 21 sites across Germany. At three sites within this framework, the authors develop and evaluate "Social Labs" as an integrative format for local stakeholder dialogues addressing conflicts between agricultural practice and insect conservation in and around protected areas.
We conceptualize Social Labs as mutual learning spaces, established as a series of workshops and moderated working groups. A first workshop exchanges problem views and identifies topics of relevance for the local protected area. A second workshop focusses on an exchange of system knowledge between scientists of the DINA project and different societal actors in agriculture, conservation and management, and initiates a mutually agreed scenario for the future. The third and fourth workshops assess options and develop new strategies for a multi-layered problem solving.
The Social Labs build on knowledge integration techniques in transdisciplinary research and methods of conflict analysis and moderation. The relevant topics of the local dialogue are identified based on a discourse field analysis of the national discourse on insect decline and agriculture and are re-framed to the local context based on prioritisation and narratives of the participants in the Social Lab.
So far, we have identified several factors for actors in agriculture and conservation to invest time and resources into the dialogue process: 1. The perception of a local problem and of the need for action depends mostly on the availability of scientific data for the local protected area, both for agricultural and conservation actors; 2. Utilizing locally pre-existing networks supports to set-up dialogues on equal grounds and facilitates mutual trust; 3. Acknowledging stakeholder-specific framings and their discussion in peer groups foster actors' commitment to the dialogue processes.

23-O-02 - An agroecosystem living lab approach to facilitate insects in agricultural landscapes

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Environmental, economic, and socio-cultural challenges to agroecosystems are diverse, numerous, and often strongly interlinked in complex ways. To tackle such complex challenges and develop ecologically sensible, socially acceptable, and economically sustainable solutions, traditional approaches in science need to be rethought.
Agroecological Living Labs (ALLs) represent a promising approach to connect science and practice to facilitate necessary transformations. ALLs are 'transdisciplinary approaches which involve farmers, scientists and other interested partners in the co-design, monitoring and evaluation of new and existing agricultural practices and technologies on working landscapes to improve their effectiveness and early adoption' (ALL Executive report, 2019).
In the 'FInAL'-project, we apply the ALL approach to promote a long-term transformation process at the landscape scale which aims at sustaining and increasing diversity, biomass, and ecosystem services of insects.
Within three 3x3 km sized ALLs across Germany, we launched a co-design process among researchers from different disciplines and practitioners to jointly develop and implement locally adapted insect-friendly measures in agricultural fields and semi-natural habitats. The early and continuous involvement of all partners in this iterative process enables to refine the measures and incrementally adjust management plans.
The impacts of the transformed landscapes on insect populations and ecosystem services are monitored and evaluated on the landscape scale. Additionally, the economic viability and social acceptability of implemented measures will be analysed. Our local transformation efforts can also indicate new pathways for a shift on a regional or even national scale.

23-O-03 - A decade of holistic agro-environmental studies within six living labs in the Irish Agricultural Catchments Programme

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The Irish Agricultural Catchments Programme (ACP) was established in 2008 to learn how farming influences water quality and how policy impacts farming practice. The ACP has taken a holistic approach for agro-environmental studies and collaborates with over 300 farmers, monitoring environmental, agronomic and socio-economic data, using the same experimental methodology in six river catchments across Ireland. The catchments were chosen to be dominated by intensively managed agriculture and cover different types of soils, landscapes and farming systems. These "living labs" monitor nutrients in sources and storage, and in delivery points using high frequency monitoring of streamflow chemistry. Aquatic ecology is assessed twice per year in multiple sites in the rivers of each catchment. Findings have contributed to a better understanding of how nutrients are mobilised and transferred via different pathways, and have highlighted the influence of both physical and chemical environment as well as agricultural and meteorological drivers on diffuse nutrient loss to ground and surface waters, the impact on river ecology and socio-economic drivers on decision-making processes in the agricultural sector. The ACP has demonstrated that there are clearly no "one-size-fits all" solutions for mitigation of nutrient losses to water and that a better understanding of the underlying processes is required. Such understanding allows to: i) identify critical times, pathways and source areas, ii) select mitigation strategies and when to implement them, and iii) to build realistic expectations of the impact of mitigation strategies. Sustainability in an agricultural setting is not confined to environmental issues, but also includes social, economic and innovative aspects. To maximise farmers' uptake of environmental measures, actions should encompass all these aspects of sustainability. An integrated approach to water quality research and knowledge transfer is key to sustainable agriculture.

23-O-04 - ATP-AgriLandLab: A roadmap for the establishment and monitoring of Living Labs for the transformation of European agriculture

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Agriculture is one of the main drivers of biodiversity loss. Several studies concluded that minor changes within the current framework conditions would not be enough to solve the problem, a societal transformation is needed. A transformative change means "fundamental change, system-wide reorganization across technological, economic, and social factors, including paradigms, goals, and values" (IPBES, 2019). A simple way to define transformation is all the changes in the way people think, act, and organize themselves to generate more sustainable outputs, outcomes, and impacts, and finally to "change from one sociotechnical regime to another" (Geels and Schot 2007). What and how to create innovative and sustainable future land-use system is confusing, complicate, and challenging. To address this challenge, new forms of real-world experimentation are developed, such as Living Labs (LLs), that combines strengths of laboratory settings with the advantages of conducting research in the real world, with high potential to accelerate transformation processes. This document presents a roadmap to guide the design, establishment and monitoring of Living Labs in Agriculture focused on a transformative change. The roadmap ATP-AgriLandLab (Analysing Transformation Processes within Agricultural Landscape Laboratories) was designed based on a combination of theories, methodological approaches, conceptual frameworks, and case studies of successful transformation processes with and without the use of the living labs approach. The roadmap consists of 3 steps, 1. A checklist of enabling conditions needed to initiate the process of transformation; 2. A set of components and indicators to monitor the degree of transformation and Lab's transformative performance, and 3. An evaluation of the Lab's transformative impact. This roadmap in combination with Living Lab approach can be useful to learn, adjust, unlearn, re-design, test, and analyse best strategies for develop successful transformation processes in the future.

23-P-01 - Living lab Iracoubo – French Guiana

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The living Lab Iracoubo promotes and reinforce the ecological transition on an agricultural basin of several thousand hectares, by promoting agro-ecology and agroforestry system to small farmers

SESSION 24

Reconciling the Many Functions of Forests - Reserve, Resource, and Recreation

CHAIRS: ***Juliane Röder, Stefan Hotes***

Forests provide multiple ecosystem services from all service categories: provisioning, regulating, cultural and supporting, with wood playing a central role in several of them. Some ecosystem services show positive correlations and can be maximized simultaneously, while trade-offs occur between others. Forestry and the production of wood have shaped the appearance, composition and functions of forests for a long time, and some scenarios suggest that reliance on the provisioning ecosystem services of forests may increase in the future. However, maximizing wood production has had severe negative effects on the abundance and diversity e.g. of deadwood and deadwood specialists in the past, and biodiversity strategies require the reversal of these trends. Increasing demand for regulating ecosystem services makes the debate on suitable management strategies for forests more complicated: forests play a role in essential hydrological and biochemical processes which contribute to regulating ecosystem services, but maximizing these can also create conflicts with conservation goals. Adding the aspect of cultural ecosystem services leads to an even more complex situation: forests are important for recreation and tourism, and considerable cultural and economic value has been associated with these types of forest ecosystem services. However, because the economic benefits derived from these ecosystem services do not normally reach forest managers, they are not necessarily considered in decisions on how to use forests. The aim of this symposium is to address the challenges involved in the search for optimal solutions to reconcile demand for different ecosystem services of forests. We invite in particular contributions with a focus on the role of wood in relation to different ecosystem services and to biodiversity. Examples include e.g. (i) the evaluation of ecological, economic and/or cultural values of forests and deadwood from local to national scales, (ii) methods to monitor progress on the implementation of National Biodiversity Strategies and Action Plans (NBSAPs), (iii) examples for compensation mechanisms addressing the trade-off between ecological and economic optimization.

24-O-01 - Relative importance of dead wood types and microclimate on saproxylic diversity – a cross-taxonomic, experimental approach

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Inhabited by diverse saproxylic communities, deadwood contributes to forest biodiversity and guarantees important ecosystem functions. The amount and heterogeneity of deadwood as well as the abiotic environment all influence the diversity of saproxylic communities. However, as different species groups vary in their needs, straightforward management concepts on how deadwood should be enriched in forests, are hampered.
Using a large setup of 40 experimentally manipulated forest sites, we analyze the importance of different deadwood objects for fungal and coleopteran communities. We aim to disentangle the contribution of different deadwood objects (stumps, logs and snags) under various light regimes, to the local saproxylic diversity. Our analyses revealed that on stumps and especially on logs many different beetle and saprocarp species can be found. Looking at molecular fungal samples, especially snags harbored species-rich communities. The potential of snags as genetic resource therefore seems underlined. We also found significant differences among community composition. These differences were more pronounced for fungi, indicating stronger host specificity, compared to beetles. Conservation management therefore can promote biodiversity by using logs for deadwood enrichment. However, as snags seem especially relevant as genetic resource, standing deadwood should also be integrated in conservation management planning.

24-O-02 - Response of mushrooms to harsh microclimate is best explained by their toughness-protection hypothesis

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Macroclimate is an important driver of species communities via their morphological traits. Besides macroclimate, forest species are exposed to a high variation in microclimates due to variation of canopy cover. However, our mechanistic understanding of the trait responses of forest assemblages to microclimate is limited. Fungal community composition was previously found to be affected by canopy openness. However, it is unknown whether thermally relevant traits like fruit body size, color lightness or toughness structure fungal communities along with canopy openness. We test five hypotheses to explain the pattern of fungal community composition. Therefore, we exposed logs of the same size of two host tree species under experimentally created closed and open forest canopies in a random-block design for four years of the initial decay stage. Closed and open canopies reflect benign vs. harsh microclimates. We determined the fungal fruiting community of two fungal lineages (Basidio- and Ascomycota) and analyzed fruit body size, color lightness and toughness. Using linear mixed-effects models, we found consistently and significantly more tough-fleshed fruit bodies under open canopies. Although we found significant community responses of fruit body size and color lightness to canopy openness, they were not consistent across fungal lineages or host tree species within lineages. Our results further showed that fungal assemblages responded mainly through fruit body toughness to canopy openness, compared to fruit body size or color lightness. Our findings underline the importance of fruit body traits for the structuring of mushroom-forming fungal assemblages and suggest phenotypic adaptation to conditions associated with harsh microclimates. Across lineages, we found support only for the *toughness-protection hypothesis,* stating that tough-fleshed fruit bodies protect from heat and drought via desiccation protection. Our results imply that a predicted increase in canopy openness will select fungi with tough-fleshed fruit bodies across lineages. Further, such conditions will select smaller fruit bodies in Ascomycota.

24-O-03 - What does a threatened saproxylic beetle look like? Modelling extinction risk using a new morphological trait database

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The extinction of species is a non-random process, and understanding why some species are more likely to go extinct than others is critical for conservation efforts. Functional trait-based approaches offer a promising tool to achieve this goal. In forests, deadwood-dependent (saproxylic) beetles comprise a major part of threatened species, but analyses of their extinction risk have been hindered by the availability of suitable morphological traits. To better understand the mechanisms underlying extinction in insects, we investigated the relationships between morphological features and the extinction risk of saproxylic beetles. Specifically, we hypothesised that species darker in colour, with a larger and rounder body, a lower mobility, lower sensory perception, and more robust mandibles are at higher risk. We first developed a protocol for morphological trait measurements and present a database of 37 traits for 1157 European saproxylic beetle species. Based on 13 selected, independent traits characterising aspects of colour, body shape, locomotion, sensory perception and foraging, we used a proportional-odds multiple linear mixed-effects model to model the German Red List categories of 744 species as an ordinal index of extinction risk. Six out of 13 traits correlated significantly with extinction risk. Larger species as well as species with a broad and round body had a higher extinction risk than small, slim and flattened species. Species with short wings had a higher extinction risk than those with long wings. On the contrary, extinction risk increased with decreasing wing load and with higher mandibular aspect ratio (shorter and more robust mandibles). Our study provides new insights into how morphological traits, beyond the widely used body size, determine the extinction risk of saproxylic beetles. Moreover, our approach shows that the morphological characteristics of beetles can be comprehensively represented by a selection of 13 traits. We recommend them as a starting point for functional analyses in the rapidly growing field of ecological and conservation studies of deadwood.

24-O-04 - The phylogenetic signature of Atlantic Forest restoration: a systematic review

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Ecological restoration can be an important tool for the conservation of plant phylogenetic diversity. Amongst tropical ecosystems in which restoration is paramount, special attention should be given to the Brazilian Atlantic Forest due to the high levels of endemism, species richness, and vast degradation. Besides recognizing the need to establish restoration projects, we need to understand how plant taxonomic and phylogenetic diversities are considered during restoration. To evaluate how taxonomic and phylogenetic diversities are represented during the restoration of Brazilian Atlantic Forest, we conducted a systematic review of the scientific literature on Atlantic Forest restoration. We assessed (i) the phylogenetic diversity of restoration projects; (ii) which plant families are more frequent in restoration projects; and (iii) what portion of the Atlantic forest plant diversity is represented by restoration projects. Through the systematic review, we obtained the list of plant species used when conducting restoration of Atlantic Forest in Brazil. We then calculated the phylogenetic diversity of restoration projects considering the total number of studies collected. This was compared to the phylogenetic diversity of the Brazilian Atlantic Forest. Restoration projects represent a considerable diversity of tree species. In total, restoration projects included 405 species of trees from 243 genera and 72 plant families. However, nearly 30% of the species used across all studies belong to the Fabaceae family. Meanwhile, the Melastomataceae family, which is an important group in the Atlantic forest, was poorly represented (N = 6). We argue that the inclusion of phylogenetic information based on local reference ecosystems during planning of future restoration projects can contribute to the conservation of Atlantic Forest evolutionary history.

24-P-01 - The BioHolz Project – biodiversity and ecosystem services of forests with a focus on (dead)wood

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The BioHolz project (bioholz-projekt.de) combines researching biodiversity and ecosystem services of forests to support the implementation of the German National Biodiversity Strategy. The project assembled researchers with biodiversity, forestry and socio-economic perspectives, as well as forest managers from an NGO and from church forests. The project's results will be valuable to inform decisions supporting the current UN Decade on Restoration 2020-2030. The project established several experiments on the importance of deadwood, with different amounts, distributions and types of deadwood. Saproxylic arthropods were more abundant in sunny than in shady conditions, especially in the first years after plot establishment and in canopy deadwood. The most important factor for fungal diversity was tree species identity. Deadwood retention lowered browsing pressure on fir saplings by roe deer while damage by rodents increased, but not as much. The project developed a model to optimize opportunity costs at the level of individual forestry enterprises. The economic costs of increasing deadwood abundance depended on the tree species, the sorting strategy and the time horizon, in which the deadwood objective was reached. A Delphi survey resulted in three scenarios for future forest development, intended to inform decision makers. The attitude of forest visitors to deadwood could be ambiguous, but higher proportions of deadwood were nevertheless associated with more aesthetics or recreational value. Project results showed that forest multifunctionality is limited to subsets of ecosystem services at the stand level, due to tree species composition. Therefore, multi-purpose forestry can be achieved by managing a variety of forest types at the landscape level. Along forest paths and in talks, the diocese Passau explained its well-established concept of forestry preserving creation. And the LBV developed a hands-on guide on how to manage forests with a focus on conservation.

SESSION 25

Sown Wildflower Areas as an Integral Part of Multifunctional Agricultural Landscapes

CHAIRS: ***Tim Diekötter, Frank Jauker***

Sown wildflower areas have become a popular agri-environmental scheme to conserve biodiversity and promote associated ecosystem services in agricultural landscapes. Competition for space in intensively managed agricultural regions, however, is intense and financial resources for subsidies are limited. To facilitate implementation of wildflower areas, knowledge on optimal design and installation practices is required. This includes insights into how flowering areas benefit agro-biodiversity at local (e.g. moderated by size or floral composition) and landscape scales (e.g. moderated by connectivity with additional flowering areas or semi-natural landscape elements in their surroundings). A great potential of flowering areas lies in their optimization towards multiple target organisms and the promotion of multiple ecosystem services such as pollination, biological control and water purification. Here, we are interested in studies that advance our understanding of the efficient functioning of sown wildflower areas towards a dynamic, locally and regionally adapted tool integral to creating the multifunctional agroecosystems of the future.

25-O-01 - Managing flower plantings for wild bee conservation – Lessons learned from the BienABest project

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In many regions of the world, there is strong evidence for a decline of wild bees. This has prompted concerns about the safety of pollination services, but also the intrinsic value of wild bee biodiversity. Flower plantings have been shown to increase abundance of bees and improve pollination services in the surrounding landscape. However, only few studies exist that explore as to whether flower plantings can play a role in wild bee conservation. The aim of our study was to investigate how the plant composition and management of flower plantings contribute to the diversity and abundance of wild bees in agricultural areas. The study is embedded in the long-term project BienABest (www.bienabest.de), that aims to increase wild bee diversity and to secure the ecosystem service of pollination. In a large-scale monitoring project in 20 research areas distributed over Germany, wild bee data were collected on 60 flower plantings for two consecutive years. In flower plantings, bee abundance and species richness were intricately linked to a high plant species richness and a constant bloom throughout the season. In the first year, a complimentary blooming phenology of annual and perennial plants contributed to a stable bloom throughout the season. In the second year, partial mowing of flower plantings during the mid-season enhanced floral resources in the late season. As a result, bee abundance and richness in flower plantings was enhanced in the second year. In our study, we were able to identify and discuss key factors for promoting bees in flower plantings.

25-O-02 - Attractiveness of different flower strips for beneficial arthropods of agricultural landscapes

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Flower strips are a prominent agri-environmental scheme (AES) with the potential to counteract the global decline of wild insect populations. The main goal of such AES is to protect biodiversity and maintain ecosystem services such as pollination and pest control. The approach of promoting populations of natural enemies of insect pests by optimizing their habitat is a promising method of integrated pest management.
In a three-year field study (2020-2022), two annual and two perennial, commercially available flower strip mixtures are tested with regard to their attractiveness for beneficial arthropods on three different farms in NRW, Germany. The flower strip mixtures as well as a control are organized in a replicated plot design (n = 3) at each location. Beneficial arthropods such as hoverflies, ladybirds, lacewings, parasitic wasps, web spiders, ground beetles and predatory bugs are sampled in nine rounds in a ten-day rhythm in summer (June – September) using standardized sweep netting and pitfall traps in each flower strip plot. Furthermore, the available flower resources in each plot are recorded.
First results from of 2020 show that the tested mixtures differ in their attractiveness for beneficial arthropods. For example, compared to treatments, the most species-poor mixture shows the highest attractiveness for predatory bugs by the time when it is dominated by plants of the family Fabaceae. In contrast, the most species-rich mixture shows the highest attractiveness for ground beetles over the whole sampling period, while hoverflies do not differ in abundance between treatments, except for the control. Therefore, our results show that attractiveness of flower strips varies between groups of beneficial arthropods. The observed differences are subject to temporal dynamics and are likely driven by flower composition rather than by the number of plant species *per se*.

25-O-03 - Effects of biodiversity measures on abundance of bumblebees (*Bombus terrestris*) in agricultural landscapes assessed with a simulation modelling approach

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Since recent years, the intensification of agriculture and associated decline of insects is in the focus of politics. Thus, the extent to which agriculture can contribute to the promotion of insects is also discussed. It is well known that pollinators depend on the supply of pollen and nectar resources through time and space. A current research questions is if biodiversity measures have a significant effect on the development of pollinator populations. In a previous simulation study with honeybees, we could show that pollen and nectar rich plants on flower strips lead to an increase of honeybee colony sizes. In the present study, we investigated effects of biodiversity measures on bumblebee populations at landscape scale. We chose *Bombus terrestris*, the most common bumblebee species in Germany, as target species and used the agent-based model Bumble-BEEHAVE for simulating the population development. We used three landscapes sections with strongly different farming systems (e.g. crop diversity and rotations) and, consequently, different land-use patterns (e.g. land-use cover, structure and proportion of semi-natural habitats) located in Brandenburg, Lower Bavaria and Rhine-Hesse as realistic landscape settings for the simulations. In these landscapes, biodiversity measures, such as flower strips and areas, flowering headland and/or maize-bean mixture, were established in different ways over the last four years. The biodiversity measures differed in plant seed mixtures (pollen and nectar supply of plants), spatial proportion and distribution between the landscape sections. We simulated the development of bumblebees with and without implementations of the biodiversity measures in order to assess their effect on population size. Analyses of the simulation results are currently in preparation.

25-O-04 - What are we talking about? Patterns in the implementation of wildflower strips and fallows by German farmers

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Wildflower strips and fallows can be effective measures for promoting biodiversity in agricultural landscapes. Their share on arable land decreased from 6 % in 2006 to 2 % in 2009 in Germany. The implementation of ecological focus areas (EFA) in 2015 led to an increase, but fallows cover only 3 % of the arable land in 2019. In the next funding period of the CAP, fallows and flower strips will play a very significant role in the German implementation of eco schemes. These measures will only have a substantial impact if these areas provide needed resources for biodiversity and are implemented in a relevant extent. Therefore, it is important to know where, how and by whom strips and fallows are generally realized to develop a minimum set of necessary legally binding obligations for an effective and efficient implementation.
We analyzed the implementation of strips and fallows on arable land as EFA or supported by agri-environmental and climate measures (AECM) between 2010 and 2018 using administrative data of five German federal states. In general, the lifetime of fallows reported as AECM is longer than of EFA, but lifetime of fallows reported as EFA increased from 2015 to 2017. Fallows and strips are mainly comparably small areas and are not distributed homogeneously in agricultural areas. They are predominantly located in regions with a low percentage of utilized agricultural area, within protected areas or on sites with steeper slopes. Fallows are mainly implemented by farms with low added value per area and managing large areas.
We suggest that measures for strips and fallows should be more focused on multi-annual options (without obligation to reseed) and obligation on maximum size should be waived. A high attractiveness for farmers is especially important in intensively used landscapes with small amounts of semi-natural habitats, without already given protection status and in areas with large field sizes.

25-P-01 - The contribution of wild flower strips to landscape connectivity

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Increasing intensive agricultural practices and increasing field sizes for cultivation of single crops led to a drastic decrease in biotope connectivity in Lower Saxony during the last decades. Recent attempts to promote biodiversity in agricultural landscapes by subsidizing flower strips still seem like a first, at best, moderately successful attempt in terms of their ecological effectiveness. Locally, a wild flower strip or field may increase biodiversity by increasing resource and habitat availability. However, without knowledge on the spatial distribution of wild flower strips, their effect on landscape connectivity remains unclear. From a landscape ecological perspective, habitat diversity and connectivity are important measures to quantify and compare the ecological state and potential of agricultural areas. With this contribution, we aim at presenting preliminary results from a study on landscape connectivity based on land use and vegetation height information, as well as own mappings of wild flower strips in two regions nearby Braunschweig, Lower Saxony.

25-P-02 - How beneficial are flower strips for biodiversity in European agricultural landscapes?

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The effects of flower strips on biodiversity have been largely evaluated in European agricultural landscapes in the last decades. There is a large body of evidence demonstrating the value of flower strips in particular for beneficial arthropod populations and their regulating ecosystem services (i.e. pollination and biological control). However, a large variability in implementation and types of flower strips across Europe make it difficult to come up with a generalized validation of their benefits. For example, the dimension (width, area), species mixture and management of the strips as well as their ecological contrast with control treatments and surrounding landscape (simple or complex) vary according to regional and country regulations. Such variability may be reflected in different levels of habitat quality at flower strips and controls, and therefore may provide misleading information regarding the effectiveness of this agri-environmental scheme. In this study, we developed a systematic review of literature to assess the level of benefit (effect size) of flower strips for arthropods (pollinators and predators), depending on the contrast of habitat quality between strips and chosen control habitats of the respective studies. Our hypothesis is that the more distinct the contrast in habitat quality is between them, the higher is the level of benefit reported. We performed a systematic search in bibliographical databases for studies addressing the effects of flower strips on arthropods in Europe during 2009 - 2021. Forty-two out of 112 screened publications were selected based on data availability for response variable (richness, abundance) and treatments (flower strips, control). About 78 % of the literature reported positive effects of flower strips. Crops, grassy and spontaneous margins were mostly used as control treatment (23 - 45 %) compared to other habitats (< 12 %). Further results will allow to validate the benefits of flower strips for biodiversity in Europe.

25-P-03 - Support of insect diversity through flowering areas

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The decline in biodiversity is one of the greatest challenges of our time. Since the referendum "Save the bees!" in Bavaria, the political, social and scientific focus lies particularly on the decline of insects. In this context, numerous initiatives for the creation of flowering areas were established as quick and simple solution for the conservation of insect diversity. However, many of these activities are ineffective or even pose an additional threat to native biodiversity. Therefore, clear recommendations for effective and targeted measures promoting insect diversity are necessary.

Within the project “Support of insect diversity through flowering areas” at the *Bavarian Species Conservation Centre*, we aim to compile existing knowledge about flower-rich habitats in connection with insect diversity and we want to fill knowledge gaps through targeted investigations of existing flowering areas. Provision of food, nesting and overwintering structures for insects, as well as environmental influences and effects on the native vegetation are among the central aspects. Next, we aim to clarify the suitability of plant species for the creation of flowering areas and to avoid possible negative effects through a wrong selection of species, incorporating this knowledge directly into the optimization of existing seed mixtures. The aim is to provide clear recommendations for high-quality flowering areas that support insect diversity, native flora and the biotope network.

We also focus on alternatives for conventional flowering areas. Besides the activation of field margins as extensively managed and flower-rich elements of a biotope network, we aim to provide professional support for the establishment of a donor site register for seed transfer systems. The results will be continuously communicated via events, guidelines and best-practice examples, to ensure that the many well-intentioned measures actually result in benefits for native biodiversity.

25-P-04 - How do wild bee abundance and diversity influence pollination efficiency in flowering plants?

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The interactions between pollinators and their host plants have gained more and more attention over the past years. The importance of pollination as an ecosystem service as well as the pollinator decline has reached public interest. Wild bees are known to play a key role in this process, as they can increase agricultural crop yield compared to pollination exclusively performed by honey bees. In this project, we investigated the dependency between wild bee abundance and diversity, and pollination efficiency on flower plantings and near-natural habitats. We placed potted plants of four different species at several study regions of the BienABest project (www.bienabest.de), in order for them to be pollinated by the local bee community and measured the seed production afterwards. The experiments were performed from spring to summer 2020 using plant species with different blooming periods as well as distinct floral characteristics in order to address a broad variety of wild bees. At the same time, a wild bee monitoring was performed in each study region to describe the bee species composition and abundance during our pollination experiments. We are now analyzing whether the seed production is dependent on the wild bee occurrence/community of each region. Our seed data reveal differences in quality and quantity between the different study regions. The results of this project can play an important role in implementing wild flower plantings and thereby optimizing pollination efficiency in agricultural crop yield.

25-P-05 - Bees' favourite plants – identifying keystone species for wildflower strips

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Recent pollinator decline is partially driven by the shortage or lack of floral food sources. To address this shortage, there is an increasing effort to create wildflower strips in agricultural landscapes to improve the food availability for pollinators. The plant species composition of these flower strips often depends on logistics, e.g. the availability of plant species seeds, and advice from experts. Thus, information on actual bee visitation frequencies are not readily incorporated. One possibility to overcome this shortcoming is to identify key flowering plants that support a high diversity and abundance of bee species based on empirical data. In our study, we explore which flowering herbaceous plants harbor the largest wild bee species richness and abundance and explore differences between generalist, specialist, and rare species. Therefore, we utilized the large-scale and long-term data sets of the BienABest project and the Wildbienen-Kataster on flower visitations by wild bees across seasons and combine these data with literature data on pollen collection by bees. Specifically, we wanted to answer two questions: 1) Which plant species host the highest species richness and abundance of generalists, specialists, and rare wild bees across plant communities within and across seasons? 2) Which plant species overlap in their attractiveness for all and rare species? Our results show that specific plant species, such as *Echium vulgare* or *Centaurea scabiosa*, can serve as key species for flower strips. The plant species change between seasons, e.g. early and late summer, differ in key species. Therefore, we identified core sets of plant species that support a wide range of bees including rare and specialized ones which can be supplemented with specific plant species to support distinct bee species. Overall, our study highlights the optimizing potential of specifically combining plant species from different sets to support bee diversity including specific focal species.

25-P-06 - Wildflower strips and undersown seed mixture to control aphids and minimise nanovirus infection risk in horsebean - an EIP-AGRI-project

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The increasing occurrence of nanoviruses, mainly the Pea necrotic yellow dwarf virus (PNYDV), in recent years poses severe problems for the cultivation of legumes in Austria. PNYDV is exclusively transmitted by aphids and infestations can result in considerable yield reduction or even complete loss of yield. Since no direct control measures exist, it is essential to reduce the risk of infestation. In this EIP-AGRI-project, a type of project which aims at bringing innovative approaches and scientific knowledge into agricultural practice, we aim to achieve this goal by supporting aphid antagonists by means of wildflower strips and an undersown wildflower mixture which shall in turn keep aphid population low. Consequently, the infestation risk of nanoviruses should be minimised.
The approach is tested during two field seasons on four horsebean fields managed by four partner farms in central Upper Austria in 2020 and 2021. Each study field is bordered by a wildflower strips on one side and contains an area undersown with a wildlfower mixture on the opposite side. The species-rich wildflower strips contain 35, the undersown mixture 13 species. Preliminary results from the first year are promising and show that overall abundance of aphid antagonists tends to be higher in the areas of the study fields adjacent to the wildflower strips, while the proportion of horsebean plants with symptoms of nanovirus infection was lower in these parts of the study fields. Approaches like this bear the potential to combine biodiversity promotion in agricultural landscapes with environmentally friendly pest control.

25-P-07 - Rotating uncut grass strips in intensively used meadows can promote biodiversity

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Intensification of grassland use, e.g. cutting frequency or fertilization, and the growing size of fields led to decreasing abundance of insects and grassland biodiversity. Another cause for declining insect populations is modern mowing machinery. In extensively used grassland, sometimes old grass strips are left uncut to provide shelter for insects during the mowing process. To promote insects in species-poor, intensively used meadows (4 to 5 cuts/year) as well, uncut grass strips were tested. Because biomass of these intensively used meadows is used as forage for dairy cows, the strips were planned to change their position with each cut. Each uncut grass strip and the mown meadow (control) were tested for the activity density of carabids via pitfall traps. Additionally, plant biomass samples were taken before each cut to determine the energy density of each growth. The activity of carabids was significantly higher in some of the uncut strips, but energy density was reduced compared to the control. Dry matter yield of rotating uncut strips was not reduced significantly. These results imply that rotating uncut grass strips can be a refuge for insects in intensively used meadows. In contrast to this trial, connectivity of the strips should be considered to enhance the colonisation by moving animals.

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