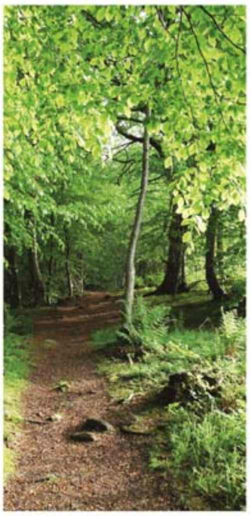
GfÖ 45th annual meeting
Göttingen | August 31st to September 4th 2015

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

Key Notes



Nancy Collins Johnson
Northern Arizona University, USA

Graeme Cumming
James Cook University, Australia

Nancy Dise
Centre for Ecology and Hydrology, Edinburgh, UK

Christian Messier
University of Quebec, Canada

Richard Primack
Boston University, USA

GFÖ 2015
Ecology for a sustainable future

Geschäftstelle der Gesellschaft für Ökologie
Institut für Ökologie
Technische Universität
Berlin Rothenburgerstr.
12
D-12165 Berlin
Tel.: 030-
31471396
Fax.: 030-31471355

Verhandlungen der Gesellschaft für Ökologie, Band 45
Herausgegeben im Auftrag der Gesellschaft für Ökologie von apl. Prof. Dr. Michael Bredemeier, Sektion Waldökosystemforschung, Zentrum für Biodiversität und nachhaltige Landnutzung (CBL), Georg-August-Universität Göttingen

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Contact:
Universität Göttingen
Prof. Dr. Michael Bredemeier,
Sektion Waldökosystemforschung, Büsgenweg 2
D- 37077 Göttingen

KCS Kuhlmann Convention Service
Heike Kuhmann
Rue des Chênes
12 CH-2800 Delémont
+ 41-32-4234384
info@kcs-convention.com

The 45th annual conference of the Ecological Society of Germany, Austria and Switzerland (GfÖ) is taking place from 31st August to 04th September 2015 at the University of Göttingen. Host of the conference is the Centre for Biodiversity and Sustainable Land Use (CBL), University of Göttingen.

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The book is also available for download as electronic document on the conference web site (www. gfoe-2015.de)

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Book of Abstracts

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Dear friends and colleagues,

I cordially welcome you to the 45th Annual Meeting of the Ecological Society of Germany, Austria & Switzerland (GfÖ) in Göttingen - a city where I spent almost 18 years of my life as both student and young scientist. At that time I was involved in organizing the GfÖ meeting 1987, and I remember well the enormous impact which the stimulating discussions and exciting lectures had on my development as an ecologist. Something, however, affected me particularly strong: the personal contact with the “Big Players” of our discipline. Knowing these people only from ground-breaking papers in high-ranking journals, I was impressed with their friendliness, openness and willingness to discuss even the most detailed issues with me and my friends. Looking ahead to our meeting this year, I hope very much that many of the early career scientists will have the chance to make a similar experience.
Environmental sciences have made enormous progress since 1987. This of course applies to fundamental issues such as community establishment and structure, biodiversity and ecological functioning etc. However, we have also learned that aspects that seem to be only loosely related to scientific ecology like human health, food production or disaster management critically depend on a diverse and intact environment. Vice versa, we have learned that diverse and intact local environments can only be maintained under conditions that allow for ending hunger and poverty, good education and gender equality or sustainable economic growth and peace (just to name a few). It is this close interplay between societal issues and nature that increasingly determines the direction of our research and practical work as ecologists. Therefore our conference is organized around interdisciplinary topics such as ecosystem services, global change effects, impacts of land use and conservation. And therefore we also direct our attention to the United Nations Summit for the adoption of the Post-2015 Development Agenda, which will be held in roughly three weeks in New York. As responsible citizens we welcome and support the Sustainable Development Goals vigorously. As scientists we call out to the decision-makers: “Sustainability will only be reached when the route to each individual goal is built on the best knowledge available. Thus, make use of our scientific achievements and further support ecological research as a vital component of future international development.”
With this in mind, I am looking forward to meet you at our 45th meeting taking place in the friendly and inspiring atmosphere of the old but still youthful university city of Göttingen.

Volkmar Wolters - **President of the GfÖ**

KEYNOTES

MONDAY 14:30; Lecture Hall MN08 — Incorporating biodiversity, novel ecosystem, ecosystem services and resilience concepts in forestry: the need of a new conceptual framework

Christian Messier[1]

[1] UQAM, Montreal, CA, messier.christian@uqam.ca

Many new concepts have "invaded" the forestry world in the last few decades and most forest managers are struggling to incorporate them into their management plan in a coherent way. This talk will briefly review how the concepts of biodiversity, novel ecosystem, ecosystem services and resilience are actually all interrelated and how they are affecting the way we manage the world forest. Different examples from various parts of the world will be provided. Then, I will discuss how viewing the forest as a complex adaptive system (CAS) could provide the necessary framework to help forest managers make sense of these new concepts and achieve their increasingly multifaceted and uncertain goals.

TUESDAY 08:30; LECTURE HALL MN08 — The Hottest Topics in Conservation Biology: Technology, Human-Natural Systems, and Long-term Research

Richard Primack[1,2]

[1] Boston University, Boston, US, primack@bu.edu

[2] Biological Conservation, an international journal, Amsterdam, NL

I will discuss three of the most dynamic areas of research and new practice in conservation biology. First, new technology is allowing to conservation biologists to expand their research in ways not previously possible. Conservation biologists are using 1) drones and satellite data to detect illegal activities, such as poaching and illegal logging, and monitor populations of rare and endangered species in remote and inaccessible locations, 2) environmental DNA to detect the presence of rare species

and arrival of invasive aquatic species, 3) DNA barcoding to identify and distinguish cryptic species, and 4) a host of technologies involving smart phones and the internet to help establish citizen science networks. Second, balancing biodiversity protection with providing for humans, a timeless but urgent problem: researchers are evaluating the environmental impact of green technologies such as wind farms and solar power, valuing ecosystem services such as carbon sequestration, involving people in conservation activities, and developing creative strategies to prevent illegal activities and to better understand why they occur. And third, expanding long-term, large-scale research and conservation: conservationists are thinking and working productively at larger scales, establishing and connecting protected areas, assisting species migrations in response to climate change, detecting ecological mismatches among species, and evaluating the success of marine reserves, restoration projects, and secondary forests. Research and conservation practice in these three broad areas will shape much of cutting edge conservation research in coming years, and will support the current activities and objectives of conservation biologists as they seek to protect and restore biodiversity.

TUESDAY 14:00; LECTURE HALL MN08 — Bye-Bye Wildflowers: How Nitrogen Deposition has Changed Europe‘s Landscape

Nancy Dise[1]

[1] Centre for Ecology and Hydrology, Edinburgh, UK, nadise@ceh.ac.uk

In this presentation I review evidence that long-term elevated reactive nitrogen (N) deposition has significantly reduced the vegetation diversity of sensitive ecosystems in Europe. There are strong theoretical reasons for N deposition to impact species adapted to low nutrient levels, and studies consistently show damage to vegetation in experimental plots exposed to high or sustained inputs of N. Habitat surveys also reveal increases in nitrophilous species and declines in N-sensitive species in Western Europe over the last 70 years. However, it is only recently that significant dose-response relationships between long-term elevated N deposition and lower plant species richness and abundance have been widely demonstrated in nature.

I will present an overview of this evidence, starting with a survey of acid grassland across Great Britain, then expanding geographically across Europe and to other sensitive communities, including heathland, sand dune, and peatland. Herbaceous flowering plants or forbs are the most impacted by N deposition, with forb species richness in acid grassland declining by approximately 35% at the mean N deposition in Europe, and by 75% at the highest N deposition. Many species exhibit a ‘threshold-like’ decline in relation to increasing N deposition, and individual species decline in abundance from the lowest level of N deposition at which any change can be identified by our analysis (6-7 kg N ha^{-1} yr^{-1}). These results may require a redefining of the critical loads concept for the protection of biodiversity, which is currently based on the existence of a level of pollution below which ‘no significant harm’ is caused.

WEDNESDAY 08:30; LECTURE HALL MN08 — Landscape ecology, conservation, and sustainable land use management

Graeme Cumming[1,2]

[1] James Cook University, Townsville, AU, gscumming@gmail.com
[2] University of Cape Town, Cape Town, ZA, gscumming@gmail.com

Spatial patterns, relationships, and exchanges – the core subject matter of landscape ecology – are increasingly important concerns for landscape management as the growing human population fragments, simplifies, and mixes up the elements of ecosystems. Contemporary conservation management has adopted the concept of the functional landscape, in which representative examples of functional sites, habitats, and ecosystems are conserved across multiple scales. However, this approach often lacks direct consideration of the human elements of conservation and landscape management. Conversely, research on social-ecological resilience has produced several frameworks for the analysis of social-ecological interactions relating to system sustainability, but has often ignored the elements of spatial variation and scale. Landscape ecology and sustainability science can be connected through the concept of functional social-ecological landscapes, which proposes that socioeconomic elements of the system (such as resource extraction, institutions, and exchanges of people and information) must align appropriately with ecological systems and processes if sustainability is to be achieved.

I will open with a conceptual overview and will then explore the interface between landscape ecology, conservation biology, sustainability, and land use management using the themes of scale, connectivity, and context, focusing on three examples: understanding the sustainability of South African protected areas, managing outbreaks of avian influenza in domestic ostriches, and navigating agricultural transitions. In all of these cases, understanding and managing both connectivity and cross-scale effects is vital for long-term sustainability. In combination, landscape ecology and social-ecological systems approaches offer a range of important insights for long-term sustainable management of multi-use landscapes and provide a useful lens through which the embedded and interactive nature of complex systems can be analysed.

WEDNESDAY 14:00; LECTURE HALL MN08 — Mycorrhizas in a Changing World

Nancy Collins Johnson[1]

[1] Nancy C. Johnson, Flagstaff, Arizona, US, Nancy.Johnson@nau.edu

In the same manner that mammals actively cultivate gut microbes to aid their digestion, plants actively cultivate rhizosphere fungi and bacteria to aid their nutrition. Mycorrhizal symbioses evolved before plants evolved roots and have facilitated the evolutionary radiation of plants and fungi. Mycorrhizas help plants adapt to the environment by increasing their access to limited soil resources. These ancient symbioses also have important consequences for soil structure and ecosystem processes. Mycorrhizas respond to - and contribute to - global environmental changes. The stoichiometry of limiting resources along with functional equilibrium between aboveground and belowground structures can help predict mycorrhizal dynamics in a changing world. The abundance of mycorrhizas frequently increases in response to elevated concentrations of atmospheric carbon dioxide as belowground resources become relatively more limited than carbon. Mineral fertilizers often have the opposite effect on mycorrhizas and reduce mycorrhizal abundance. This change can reduce soil carbon stocks. Different global carbon models vary widely in their predictions of the dynamics of the terrestrial carbon pool, ranging from a large sink to a large source. A better understanding of mycorrhizal mediation of carbon storage can inform earth system models and will likely improve the accuracy of their predictions.

SESSIONS
ORAL & POSTER
PRESENTATIONS

Session 2 – Functional plant ecology

CHAIRS: MAAIKE BADER, ARTHUR GEßLER, GÜNTER HOCH

O1 - Transgenerational effects of climate change: Maternal extreme weather affects offspring of two dwarf-shrubs

Julia Walter[1,3], David Harter[2], Carl Beierkuhnlein[2], Anke Jentsch[3]

[1] University of Hohenheim, Landscape and Plant Ecology, Stuttgart, DE, walter.julia@uni-hohenheim.de
[2] Bayreuth University, Biogeography, Bayreuth, DE
[3] Bayreuth University, Disturbance Ecology, Bayreuth, DE

Climate change alters hydrological regimes and leads to shifts in plant community composition, thereby changing individual plant resource- and water availability. Both, maternal seed provisioning and offspring germination are known to be strongly affected by resource availability and environmental conditions. Little is known, however, on how extreme climatic events experienced by mother plants might influence offspring phenotype and performance after germination. There is a lack of studies regarding transgenerational effects of perennial species, despite their importance for the structure and dynamics of ecosystems. We studied the impacts of extreme weather events (drought, heavy rain) on mother plants growing in different community assemblies (differing species numbers) for germination of their seeds and for the subsequent development of juveniles. Two perennial dwarf shrub species (*Genista tinctoria* and *Calluna vulgaris*) were investigated over a period of two years. Generally, stress for mother plants (drought for *G. tinctoria* and high intraspecific competition for *C. vulgaris*, respectively) caused earlier germination of seeds. Seeds of heavy rain-treated *G. tinctoria* mothers showed reduced and later germinability. Further, growth rates were higher in the second year and leaves showed a lower C:N ratio when mothers had been treated with heavy rain. The lower C:N ratio could also indicate a transgenerational adaptation as more metabolic and less structural tissue is beneficial to sustain high growth rates under optimal water supply. Seedlings of *C. vulgaris* did not reveal such long-termed changes. Flowering onset, final height and biomass after two years were not affected by the maternal environment of neither species. Our findings show that variation in the maternal environment cannot only affect number, but also performance of offspring. This emphasizes the importance of addressing transgenerational effects when estimating future population responses to climate change impacts and their eco-evolutionary developments as well as species distribution shifts.

O2 - Where, why and how? Explaining the low temperature range limits of temperate tree species

Christian Körner[1], David Basler[1], Günter Hoch[1], Chris Kollas[1,2], Armando Lenz[1], Christophe Randin[1,3], Yann Vitasse[1,4], Nicklaus Zimmermann[4]

[1] University of Basel, Basel, CH, ch.koerner@unibas.ch
[2] Potsdam Institute of Climate Change, Potsdam, DE
[3] University of Lausanne, Lausanne, CH
[4] Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft, Birmensdorf, CH

Attempts at explaining range limits of temperate tree species still rest on correlations with climatic data that lack a physiological justification. Here we present a synthesis of a project that aimed at resolving that question. We employed climatology, biogeography, dendrology, population and reproduction biology, stress physiology and phenology to provide an eco-evolutionary explanation of the low temperature limits of temperate tree species. We combine results from in situ elevational (Swiss Alps) and latitudinal (Alps vs Scandinavia) comparisons, from common garden and phytotron studies, as well as laboratory experiments, for 8 common European tree species. We show that absolute temperature minima in tree tops can be predicted from weather station data, but such winter extremes do not explain range limits. The ranking of the range limits of species is similar across elevation and latitude. Recruitment is not limitated at the current upper elevational limit of any species. Reciprocal common gardens revealed that environmental influences on growth and phenology of seedlings exceeded those of seed origin. Spring flushing in adults trees turned out to be timed in such a way that the probability of freezing damage is minimized, with a uniform 80-year safety margin across elevations and taxa. More resistant species flush earlier than less freezing resistant species. Tree ring formation at the range limit is not related to season length, but to growing season temperature. Young trees, grown at temperatures colder than at their natural range limit, show incomplete lignification and maturation. We conclude that the range limits of the examined taxa are set by the interactive influence of phenology, freezing resistance in spring, and the time required to mature tissues. Microevolution of spring phenology compromises between demands set by species-specific freezing resistance of immature tissue and evolutionary life history traits related to tissue maturation.

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O3 - “Are 3°C too much?” – Thermal niche breadth in Bromeliaceae and global warming

Lilian-Lee Müller[1], Dirk C. Albach[1], Gerhard Zotz[1,2]

[1] Carl von Ossietzky University Oldenburg, Oldenburg, DE, lilian-lee.mueller@uni-oldenburg. de
[2] Smithsonian Tropical Research Institute, Panama, PA

In the absence of countermeasures an increase in temperature of around 6°C is predicted for higher latitudes by the end of this century. Although predictions for tropical latitudes are lower (around 3°C), , rising temperatures in the tropics are likely to have more severe consequences for tropical biota, because tropical species have generally narrower climatic niches due to a higher degree of climatic stability and higher niche specialization.

Even though temperature affects all ontogenetic stages, seed germination, as part of the regeneration niche, is considered a critical first step determining success or failure of plant development. Consequently, the regeneration niche of a species inevitably impacts overall niche breadth and thus represents a potential bottleneck for the distribution of a species.

Bromeliaceae, epiphytic and terrestrial members, represent a major component of the structural diversity of Neotropical forests. We chose 41 species of this family investigating their germination response to temperature to assess whether the thermal regeneration niche breadth of these bromeliads is wide enough to cope with the predicted increase in temperature of around 3°C. To this end we conducted germination experiments at different temperatures under controlled conditions in the laboratory to establish thermal performance curves as a proxy of their thermal niche breadths (and temperature optima) based on the Germination Index.

Our results are surprising. They suggest that the predicted temperature rise would not negatively affect seed germination in the majority of species. On the contrary, most of the species would be closer to their thermal optima after an increase in temperature, potentially leading to an increase in their performance. Note, however, that this statement ignores possible aggravation in water relations at higher temperatures. Moreover, first results of additional experiments indicate that potentially positive effects of increasing temperatures on seed germination could be offset by negative effects on other ontogenetic stages of plant development, such as seedling establishment or later plant growth.

O4 - Studying the effect of heteroblastic changes in epiphytic bromeliads with a functional structural plant model

Joachim Beyschlag[1], Gerhard Zotz[1,2]

[1]Carl von Ossietzky Universität, Oldenburg, DE, j.beyschlag@uni-oldenburg.de
[2]Smithonian Tropical Research Institute, Panama, PA

The functional relevance of heteroblasty, an abrupt morphological change in the ontogeny of angiosperms, is still ambiguous and lacks a more comprehensive explanation.

In the ontogeny of epiphytic Tillandsioids (Bromeliaceae) such a change occurs when small atmospherics transform into bigger tank forming individuals. The transition from narrow leaves to the development of broader does not only change the water status of the plant but in fact affects the whole plant architecture.

A functional structural plant model (YplantQMC) allowed a systematic analysis of the effects of various types of leaf morphology and leaf architecture and their combination on light capture. Morphological differences found between heteroblastic species from exposed sites and the understory could be explained in this context.

With this modeling approach it was possible to compare light capture availability of existing atmospherics and tanks by virtual reconstructing plant individuals. Moreover the transmission of morphological characteristics to the respectively other life form allowed the analysis of artificial plant morphologies as well as comparing different strategies throughout the ontogenetic development in terms of light capture.

Modifying existing plant morphology showed increasedself-shading by overlapping broad leaves which supports the hypothesis that species from a light limited environment such as the understory depend on the early atmospheric life form in terms of light capture.

Thus the heteroblastical change for species in the understory cannot be seen exclusively as an adaption to prevent drought events as it also comprises a strategy of light capture optimization.

O5 - Phylogenetic signal and trait covariation across multiple axes of plant functional differentiation

Oliver Purschke[1,3], Nathan Swenson[2], Walter Durka[1,4], David Eichenberg[6], Jens Kattge[1,7], Stefan Michalski[4], Michael Scherer-Lorenzen[5], Stefan Trogisch[1,3], Christian Wirth[1,6], Helge Bruelheide[1,3]

[1] German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE
[2] University of Maryland, Department of Biology, College Park, US
[3] Martin-Luther-University Halle-Wittenberg, Institute of Biology/Geobotany and Botanical Garden, Halle (Saale), DE, oliver.purschke@idiv.de
[4] Helmholtz Centre for Environmental Research UFZ, Department of Community Ecology, Halle (Saale), DE
[5] University of Freiburg, Faculty of Biology/Geobotany, Freiburg, DE
[6] University of Leipzig, Systematic Botany and Functional Biodiversity, Leipzig, DE
[7] Max Planck Institute for Biogeochemistry, Functional Biogeography, Jena, DE

To detect "hidden" axes of plant functional diversity (FD) and to get a better grasp on why phylogenetic diversity (PD) usually outperforms FD in biodiversity-ecosystem functioning (BEF) studies, we (i) tested whether trait similarity across multiple axes of plant functional differentiation (including those that are difficult to measure) reflects evolutionary relatedness between species (i.e. displays a phylogenetic signal) and (ii) assessed the extent to which phylogenetic signal strength is associated with levels of covariation between traits. We explored linkages between phylogenetic signal strength and trait covariation for (i) simulated traits with strong phylogenetic signal as well as (ii) a set of ~ 80 traits, representing multiple axes of plant functional differentiation (i.e. leafs, wood, root), measured in-situ in the BEF-China project. Simulated traits with a significant phylogenetic signal were generally not correlated, suggesting that a strong phylogenetic signal in two traits (potentially representing a measured and an unmeasured trait, respectively) does not translate into high levels of trait covariation. Similarly, there was strong phylogenetic signal but only weak covariation among the three major axes of plant functional differentiation, i.e. leaf, wood and root characteristics (the two latter groups often under-represented in existing BEF studies). Combining a simulation-based approach and an exceptionally large set of traits, our study suggests (i) that phylogeny is a good proxy for "hidden" functional diversity captured in traits that are difficult to measure but (ii) that unmeasured traits with a strong phylogenetic signal do not necessarily covary with measured traits, and thus provide substantial additional amounts of trait variation, independent of variation in measured traits, which provides an additional explanation for the fact that PD outperforms FD in existing BEF studies.

O6 - Tree species richness and functional traits as predictors of productivity in tropical Andean forest

Jürgen Homeier[1], Johanna Lindemann[1], Philipp Obst[1], Jaime Peña[3], Nixon Cumbicus[2]

[1] University of Göttingen, Göttingen, DE, jhomeie@gwdg.de
[2] Universidad Tecnica Particular de Loja, Loja, EC
[3] Universidad Nacional de Loja, Loja, EC

Tree species richness is known to decrease along most elevational transects in tropical mountains. But there are still few studies on the effects of elevation on tree functional diversity in tropical forests.

We studied tropical Andean forests in southern Ecuador using a matrix of permanent plots distributed to old-growth forest stands at three elevation levels (1000m: premontane forest, 2000m: lower montane forest, and 3000 m asl: upper montane forest). Eighteen plots of 400m² were established at three different topographic positions (lower slope, mid slope, upper slope) per elevation level (54 plots in total), allowing us to investigate also the influence of topography on species richness, functional tree properties and stand productivity.

All tree stems with dbh ≥ 10 cm were recorded and identified to species. We collected samples of >700 trees from >200 different species to characterize the following functional properties: leaf area, specific leaf area, leaf toughness, foliar nutrients, wood specific gravity, bark thickness, vessel density, vessel diameter and sapwood conductivity. Furthermore, functional traits were used to estimate tree functional diversity for each plot. Stand productivity was calculated from tree diameter growth and fine litter production.

In addition to the apparent changes in forest structure, we found strong impacts of both elevation and topography on functional tree properties. In most traits the adjustment from lower slope to upper slope was similar to (but sometimes even stronger than) the shift from premontane to upper montane forest.

O7 - Functional determinants of ecological niches in 26 plant species

Martina Treurnicht[1,2], Jorn Pagel[1], Karen Esler[2], Frank Schurr[1,3]

[1] University of Hohenheim, Stuttgart, DE, martinatreurnicht@gmail.com
[2] Stellenbosch University, Cape Town, ZA, martinatreurnicht@gmail.com
[3] Institut des Sciences de l'Évolution, Montpellier, FR

Developing a more refined understanding of species responses to environmental variation is a pressing issue in biodiversity research. Trait-based approaches generally aim to quantify the links between species' functional traits and variation in the abiotic environment with a number of response traits that directly determine plant performance along environmental axes. For example, plant performance in response to climatic variation is found to be better predicted by leaf and wood traits whereas responses to disturbance rather depend on plant height, life history type and reproductive traits. Moreover, interspecific differences in functional traits can enable more differentiated responses to the environment.
Recent studies highlight the potential of trait-based studies to explain interspecific variation, notably in demographic rates. However, how functional traits explain demographically derived species niches is not well understood. In light of this, we will test if functional traits (major leaf, wood, seed, life history and reproductive traits) can be used as informative performance currencies to understand the ecological niches of 26 shrub species. Our trait data was collected in the Cape Floristic Region, a global biodiversity hotspot, and covered at least 10 population-level records per species and collected throughout the species' geographical ranges. We will investigate if traits can explain interspecific variation in maximum population growth rate and different niche axes; such as niche optimum (the value for which population growth is maximal) and niche width (the environmental range for which population growth is positive) along individual environmental factors. A key question for the emerging field of functional biogeography is to quantify the extent to which functional traits can explain interspecific variation in species niches and can help to better understand large-scale variation in the functional strategies of plants.

O8 - Assessing the impacts of invasive plants on ecosystems through remote sensing

Michael Ewald[1], Sandra Skowronek[2], Raf Aerts[3], Jens Warrie[3], Ruben Van De Kerchove[4], Pieter Kempeneers[4], Olivier Honnay[3], Jonathan Lenoir[5], Ben Somers[3], Hannes Feilhauer[2], Sebastian Schmidtlein[1]

[1] Karlsruhe Institute of Technology, Karlsruhe, DE, michael.ewald@kit.edu
[2] University of Erlangen-Nürnberg, Erlangen, DE
[3] University of Leuven, Leuven, BE
[4] VITO, Mol, BE
[5] Jules Verne University of Picardie, Amiens, FR

The impacts of invasive plant species on ecosystem properties have been well documented through field observations and experiments. Although strongly context-dependent, non-manipulative field studies typically examine these effects by comparing highly-invaded and non-invaded sites and focus on single habitat types. For this reason, findings on ecosystem impacts of plant invasions are often difficult to generalise.

Within the framework of the BiodivERsA funded project DIARS (Detection of invasive plant species and assessment of their impact on ecosystem properties through remote sensing) we introduce a spatially explicit approach combining several remote sensing-based techniques that allows to study context-specific effects of plant invasions on ecosystem functioning. Using this novel approach, we aim at analysing the effects of invasive plant species on ecosystem properties (e.g. vegetation structure, biomass, leaf nutrient contents and plant community composition) in different invasion stages and quantifying these effects at the landscape scale.

In a first case study, we examined the effects of *Prunus serotina* on the vegetation structure across a large (144 km^2) mixed deciduous forest in northern France. For this purpose we used high resolution airborne LiDAR data to create maps of forest structural attributes. These LiDAR-derived maps were, in a second step, linked to detailed information on the spatial distribution of *P. serotina*. Here, we would like to provide more details about our innovative approach and present first results.

O9 - The hydrogen isotope composition of leaf wax lipids reveals changes in the plant-internal carbon metabolism over the past century

Ansgar Kahmen[1,2], Marc-Andre Cormier[2], Bruno Gamarra[1,2]

[1] University of Basel, Basel, CH, ansgar.kahmen@unibas.ch
[2] ETH Zurich, Zurich, CH, ansgar.kahmen@unibas.ch

Understanding the responses of plants and ecosystems to global environmental change is a key challenge for ecological and environmental sciences. In this respect, the analyses of stable C, N and O isotopes in biological archives, e.g. tree rings, are well established. These analyses have, for example, revealed that intrinsic water

use efficiency of trees has increased by more than 20% in Europe in the past century. In contrast to C, N and O isotopes, the analysis of hydrogen isotopes (δ^2H) in plant organic material has not yet been established as tool in modern ecological or biogeochemical research. With the development of new analytical instruments that allow the hydrogen isotope analysis of selected plant compounds there is, however, a growing interest to explore the power of δ^2H values in leaf wax lipids as a tool for ecological and biogeochemical research.
In my talk I will present the results from recent experiments, where we show that the δ^2H values of plant-derived lipids reflect the carbon metabolism of a plant. Specifically, I will show that plants that rely for their tissue formation on recently assimilated C have δ^2H values in their n-alkanes that are up to 60‰ more negative than plants that depend for their tissue formation on stored carbohydrates. As such, the δ^2H values of plant-derived lipids are a powerful new tool that indicates the plant internal C sources used for tissue formation. To explare whether plant internal C sources used for tissue formation have changed in plants in response to global environmental chamnge, we analyzed the δ^2H values of archived plant samples from the Rothamsted grassland experiment that started in 1860. Our analyses revealed that leaf wax δ^2H values have declined in the past by more that 40‰, suggesting that plants have shifted their C metabolism and utilize more recent assimilated C for tissue formation than in the past. Our results are among the first to show that in addition to water used efficiency, plants are also responding in their internal C metabolism to global environmental changes.

O10 - Primary production of macrophytes and phytoplankton in a shallow coastal bay of the southern Baltic Sea

Maike Piepho[1]

[1]University of Rostock, Rostock, DE, maike.piepho@uni-rostock.de

High nutrient input into coastal waters of the Baltic Sea during the past decades resulted in many coastal areas in a shift from a clear, macrophyte-dominated state to a phytoplankton-dominated state, characterized by high turbidity. Despite recent reductions of nutrient inputs the systems have not recovered; turbidity is still high. However, in some areas, such as the Darß-Zingst Bodden-Chain (DZBK) macrophytes can be found once again. The here presented project is to gain insight in whether the current state of the DZBK is a transition to the macrophyte-dominated state or a distinct stable state. Therefore, the relative importance of the two groups of primary producers (macrophytes and phytoplankton) is analyzed and the total productivity of the system is calculated. Photosynthesis-irradiance curves, biomass distribution and data on global irradiance as well as under water irradiance build the basis for a balance model for the calculation of primary productivity. Understanding of the state and the system DZBK is of great importance especially against the background of achieving the good environmental status as defined by the EU-water framework directive.

O11 - Does history matter for biotic interactions of plants?

Susanne Wurst[1], Takayuki Ohgushi[2]

[1] Freie Universität Berlin, Berlin, DE, s.wurst@fu-berlin.de
[2] Center for Ecological Research, Kyoto, JP

Plants interact with a wide range of organisms above and below the ground. Here, we ask if the history of biotic interactions matters for future biotic interactions of plants. We propose that history (or legacy) effects are mainly transferred by changes in plant and/or soil characteristics. Changes in plant and soil characteristics caused by biotic interactions such as feeding on plant materials can be short- or long-term. In the short term, plants can react with a rapid defense response against feeders that often vanishes when the feeding ceases. In the long term, plants may invest in new leaves or roots to compensate for feeding damage or translocate nutrients to unattacked plant parts. In soil, carbon input into the rhizosphere can be changed in the short term and affect the activity of the microbial community, while litter quality changed by feeding may affect decomposition and soil biota communities in the longer term. Overall, long-term changes in plant and soil characteristics likely persist after the biotic interaction ceases and may affect future interactions of plants. In consequence, the performance of plants, the composition of biotic communities and the functions of ecosystems may be affected by past biotic interactions. We conclude that the history of past interactions should be included in studies on biotic interactions for a better understanding of current community organization.

O12 - Understanding resource availability and competition between grassland plant groups and how this can help us restore grassland diversity.

David Johnson[1], Jane Catford[1], Philip Gibbons[1], Don Driscoll[1]

[1] Australian National University, Canberra, AU, David.Johnson@anu.edu.au

Vast areas of diverse native grassland in Australia have been modified for agriculture or are poorly managed and require restoration. Understanding the mechanisms which determine floristic diversity is necessary for their restoration. Competition for available resources within and between species is a key factor determining which plant species can co-exist in any ecological community. Most research relating to grassland competition focuses on the response of plant species and communities to treatments that manipulate resource availability in some way. We are conducting a field experiment to measure changes in two directions: firstly the changes in resource availability that occur as a direct or indirect result of manipulations to a grassland community, and secondly plant community responses to changes in resource availability. The experiment is located in a *Themeda triandra* dominated native grassland in temperate South East Australia.

We manipulated the competitive hierarchy between three broad plant groups within temperate grasslands: tussocks, exotic forbs and grasses, and native forbs. Treatments included tussock thinning, weed removal, and litter removal. Seed for 12 native forb species was added. We quantified changes in the availability of essential growth resources (nutrients, moisture, and light) and changes in physical structure that occurred in a growing season. These results and plant group responses including native forb germination and initial compositional changes will be discussed along with implications for the design of grassland restoration programs.

O13 - Mycotrophy level as a factor for competitive outcome under conditions promoting parasitism

Martina Friede[1], Stephan Unger[1], Wolfram Beyschlag[1]

[1] Universität Bielefeld, Bielefeld, DE, friede@uni-bielefeld.de

Interactions of plants with arbuscular mycorrhizal fungi (AMF) may range along a broad continuum from strong mutualism to parasitism. The mycorrhizal benefit of a plant is determined by climatic and edaphic conditions promoting the balance between carbon costs vs. nutritional benefits. Thus, environmental conditions promoting either parasitism or mutualism may influence the mycorrhizal growth response (MGR) of a plant and in consequence play an important role in plant-plant interactions.

In a controlled field experiment with dry-acidic grassland species, we tested the hypotheses that (1) the highly mycotrophic forb *Hieracium pilosella* exhibits decreased mycorrhizal benefits under conditions promoting AMF parasitism, whereas, irrespective of the environmental conditions, AMF has no influence on the growth of the less mycotrophic grass *Corynephorus canescens* and thus, that (2) under these conditions, *H. pilosella* loses competitive strength in interactions with *C. canescens*.

Both species were planted in a sand pit located in a common garden area usinga target-neighbour approach. Mycorrhizal and non-mycorrhizal plants were exposed to different phosphorous and nitrogen fertilization treatments under two different light regimes to induce a broad range of mycorrhization effects along the mutualism-parasitism continuum.

In contrast to the hypotheses, single plants of both species showed no AMF-induced parasitism, whereas competition with *H. pilosella* induced strongly decreasing MGR in *C. canescens* with increasing parasitism promoting conditions. My corrhization in *C. canescens* was highest in interspecific competition together with lowest MGR in this treatment. Surprisingly, *H. pilosella* did not show any signs of parasitic effects but instead high MGRs in all treatments. Obviously, under parasitism promoting conditions, AMF decreased competitive strength of the lower mycotrophic species *C. canescens*, which is the dominant competitor under mutualism

promoting conditions.
Thus, environmental effects on the mutualism-parasitism continuum of AMF-symbiosis may have important consequences for the outcome of plant-plant interactions, particularly in competitors with different mycotrophy levels.

O14 - Plant diversity relaxes Janzen-Connell feedbacks and balances seed predation in an experimental grassland community

Jan-Hendrik Dudenhöffer[1], Gesine Pufal[1], Christiane Roscher[2], Alexandra-Maria Klein[1]

[1] Nature Conservation and Landscape Ecology, Institute of Earth and Environmental Sciences, University of Freiburg, Freiburg, DE, jan.dudenhoeffer@nature.uni-freiburg.de
[2] UFZ, Helmholtz Centre for Environmental Research, Department of Community Ecology, Halle, DE

Janzen-Connell effects describe negative effects of a conspecific plant on the survival of its progeny and are important for the maintenance of plant diversity. Notably, seed predation is a prominent driver of Janzen-Connell effects. However, only few studies addressed how plant diversity affects seed predation in the context of Janzen-Connell effects. We assumed in concordance with the mechanism of density dependent Janzen-Connell effects, that the conspecific impact on seed predation decreases with increasing plant species richness. This is because higher species richness decreases the relative abundances of single species.

We studied the effects of conspecific presence and plant species richness on seed predation on three grassland species (*C. jacea, G. pratense, K. arvensis*). We also examined the impact of plant species richness and invertebrate seed predator diversity on the similarity of predation on the three species. We offered the seeds in a cafeteria experiment, targeting four seed predator exclusions (access for arthropods and slugs, access for arthropods, access for small arthropods, access for slugs) in experimental plots covering a gradient of 1, 2, 3, 4, 8 plant species where the conspecific plant was either present or absent.

For two of the species (*C. jacea, K. arvensis*) seed predation was higher in presence of their conspecifics. This effect was mitigated with increasing plant species richness. Both, plant species richness and seed predator diversity increased the similarity of seed predation on the three species.

Our results show that Janzen-Connell effects act in local grassland plant communities. In this context, conspecific abundance and thus its impact on seed predation decreases with increasing species richness of the community. Together with the balancing effect of plant and seed predator diversity on seed predation, this suggests that high plant diversity has a self-stabilizing effect by lowering the reproductive success of dominant species.

O15 - Influence of wild and domesticated cotton on a generalist herbivore

Steffen Hagenbucher[1,2], Peter Anderson[2]

[1]Agroscope, Institute for Sustainability Sciences, Zürich, CH, steffen.hagenbucher@agroscope.admin.ch
[2]Chemical Ecology, Swedish University of Agricultural Sciences, Alnarp, SE, steffen.hagenbucher@agroscope.admin.ch

Since the start of the agricultural revolution crop plants have undergone a tremendous change caused by human selection. We created plants that are extremely well adapted to provide humans with high yields, however in recent years it became apparent that this came with a cost, especially an increased susceptibility against herbivores and plant disease. Insect herbivores will often perform much better on a crop plant than their wild relatives, which in turn should make crop plants more attractive to herbivores.

We investigated how the domestication of cotton influences the preference and performance of the generalist moth *Spodoptera littoralis*. Therefore we analyzed larval development on different wild and domesticated cotton, and tried to correlate larval performance with the host-choice behavior of larvae and adult moths. Additionally, we analyzed the volatile profile of the selected as an indicator for metabolic changes during domestication.

Larval performance was indeed worse on wild plant types compared to domesticated plants. Interestingly an improved performance on domesticated plants did not necessarily translate into preference by larvae and adults, as wild and domesticated plants were often equally attractive to the animals. However this was not the case in all wild plants, the wild species *Gossypium raimondii* was repulsive for both larval and adult stages of *S. littoralis*. Additionally, this plant seems to be capable of projecting associational resistance to nearby domesticated cotton plants. The observed volatiles profile did change strongly between types, with the wild plants generally having a more complex odor bouquet.

With this study we could show that preference- and performance is not always linked when wild and domesticated plants are compared, at least when generalist herbivores are compared, which often are not as choosy as oligophagus herbivores.

O16 - The okra pearl body temptation: Implications for biocontrol of the cotton aphid on okra in Cameroon

Akanksha Singh[1,2], Sharon Zytynska[1], Rachid Hanna[2], Veronika Mayer[3], Wolfgang Weisser[1]

[1]Technische Universität München, Freising, DE, ga46jim@mytum.de
[2]International Institute of Tropical Agriculture, Yaounde, CM, ga46jim@mytum.de
[3]University of Vienna, Vienna, AT

Many plants produce compounds to attract beneficial invertebrates in order to protect themselves against herbivory, i.e. defensive mutualism. The outcome of these plant-invertebrate interactions can vary depending on the variation among plants or the presence of other species. In an agriculture system, understanding these interactions is crucial for pest biocontrol. In Cameroon, Okra (*Abelmoschus esculentus*) is a commonly cultivated vegetable and the cotton aphid (*Aphis gossypii*) is one of its major pests. The aphids are facultative ant-tended and aphid natural enemies include spiders, syrphid larvae and parasitoid wasps. However, natural enemy density in Cameroon is low possibly due to frequent spraying of pesticides.

In our previous studies we found that ants regularly visit okra plants. Examination of ant-plant interactions showed that Okra plants produce multicellular pearl bodies on their leaf and stem surfaces and these pearl bodies are carried back by ants to their nests. We also found that ants do not protect these aphids from their natural enemies and their interaction with aphids differs amongst okra varieties. In fact, under controlled conditions ants even reduce aphid numbers. Hence, we conducted two studies using five okra varieties: the first tested if ants preferred aphid honeydew or okra pearl bodies and; the second tested how the production of okra pearl bodies was affected by aphid presence. We found that ants' preference of pearl bodies was species specific and that aphids affected pearl body production of okra. This work has implications for aphid biocontrol, which could be enhanced further through understanding the ecology of the system.

P1 - Effect of NaCl salinity and elevated CO2 on ion relations and osmotic adjustment of a C3 (C. quinoa) and a C4 (A. nummularia) halophyte

Florian Süßel[1]

[1]Institut für Pflanzenökologie, Gießen, DE, Florian.Suessel@bot2.bio.uni-giessen.de

Global climate change, which is caused e.g. by rising atmospheric CO_2 concentration, has devastating effects on agriculture because it aggravates desertification and soil salinization. A promising solution to this problem is the sustainable use of halophytes, which in turn requires detailed knowledge about salt resistance mechanisms and plant performance under future atmospheric conditions such as elevated CO_2. As C_3 and C_4 species exhibit different CO_2 responses, the CO_2 effects on the salt resistance (with the focus on ion specific salt effects) of the close relatives *Chenopodium quinoa* (C_3) and *Atriplex nummularia* (C_4), both halophytic excreters, were studied. Plants were irrigated with different salinity levels under ambient and elevated CO_2 conditions.

Both species proved to be salt accumulators, resulting in an increase in salt concentration in the cells and thus maintaining a water potential that is more negative than that of the soil. Beside this conformity both species resist against salinity with different strategies. In *C. quinoa*, NaCl salinity led to a progressive growth reduction and accumulation of Cl^- in all tissues above osmotic requirements with hardly any excretion of salt by its bladder hairs. Na accumulation was prevented by a high K uptake. *A. nummularia* showed optimal growth between 100 – 300 mol m^{-3} NaCl and high Na accumulation at the low salinity levels. The Na-concentration in the tissues was 2-4 times higher than in the nutrient solution although significant amounts were excreted by its bladder hairs. Both species showed an energy consuming high K selectivity, which was reflected by improved K (and N) use efficiencies in case of *A. nummularia*.

Elevated CO_2 led at least partly to a significant increase of biomass production and to an improvement of ion relationsin both species. It caused for instance an increased Na (decreased K) excretion and a decreased Na (increased K) accumulation in the tissues of *A. nummularia*.

Effect of elevated CO_2 on resistance to salinity of both species will be discussed as well in the context of Cl- and Na+ toxicity as the C_3 and C_4 specific (N-) demand for photosynthesis to supply sufficient energy for the costly protection measures.

P2 - Influence of freeze-thaw cycle magnitude and frequency on within-species growth variation in Dactylis glomerata

Andrey Malyshev[1], Charlotte Dietrich[2], Juergen Kreyling[1]

[1]Experimental Plant Ecology, Institute of Botany and Landscape Ecology, Greifswald University, 17487 Greifswald, DE
[2]Forschungszentrum Jülich ,IBG-2, Wilhelm-Johnen-Strasse, Jülich, DE

In northern temperate regions winter warming may not decrease frost damage to plants due to a thinner insulating snow pack and continued occurrence of random frost events. To better project future species-specific FTC responses, within-species variation also needs to be quantified. The influence of minimum temperature and frequency of the resulting soil freeze-thaw cycles (FTC) was explored in the growth responses of 12 *Dactylis glomerata* ecoypes with contrasting climates of seed origin. After a cold acclimation period, freezing temperatures of -4°C and -8°C were administered in a factorial combination with 1, 3 and 7 FTC within a one-week treatment phase in a climate chamber. Control plants remained at 4.5°C. Survival and post-frost growth responses were recorded.

The effect size of increased mortality with higher FTC numbers was only appreciable at the -8°C minimum temperature, with a 3-fold increase in mortality with the addition of two extra FTC and no change in mortality with a further addition of 4 FTC. In surviving plants, living and dead tissue biomass and chlorophyll content also indicated that higher FTC frequency increased frost damage only at the lower minimum temperature. Within the species, ecotypes stemming from dryer climates at seed origin had higher frost tolerance. In addition, warmer climate at seed origin was positively correlated with increased growth prior to frost and decreased post-frost growth. Effects of increasing winter FTC frequency on plant survival and

growth are likely to be minor in the absence of low minimum temperatures. Furthermore, local precipitation and temperature records can be used to help project differences in FTC effects within species.

P3 - Effects of overwintering conditions on the growth and reproduction of Allium oleraceum

Timo Saarinen[1], Helena Åström[1]

[1]University of Helsinki, Helsinki, FI, timo.saarinen@helsinki.fi

Winter has been regarded as a “dormant season” with little if any biological activity. However, many evergreen plants retain their photosynthetic capacity and some species, including *Allium oleraceum* (field garlic), can even grow under snow cover. In the present study we show that overwintering conditions affect not only winter-time growth, but also summer-time growth and reproduction of *Allium oleraceum.*

Bulbs were collected from six populations of *Allium* along a maritime-continental gradient in southern Finland. The populations represented both tetraploid and pentaploid cytotypes. Dormant bulbs were planted in pots in late summer 2013. After growth onset in early autumn part of the pots were transferred from Helsinki (coastal southern Finland) to two other overwintering sites at the end of October 2013. In inland southern Finland winters are cold and snow cover is permanent (continental site), whereas mild winters and ephemeral snow cover prevail on the Åland Islands (maritime site). All the plants were transferred back to Helsinki (intermediate site) at the end of winter in late March. Thus, only overwintering conditions were modified in this experiment. The climatic gradient between the three overwintering sites resembles the expected changes in winter climate in southern Finland due to global warming.

Substantial growth of overwintering leaves was observed, as indicated by a 72% increase in leaf length during winter. Highest increases in leaf lengths were observed at the continental site and lowest increases at the maritime site. Overwintering conditions affected also growth and reproduction during the following summer. When grown under same field conditions during summer, highest total leaf lengths and highest mean weights of bulbils were recorded in plants that had overwintered at the maritime site. The overwintering conditions did not affect the number of leaves produced, the length of the flower stalk or the number of flowers or bulbils.

P4 - Interactions between transgenic insect resistance and induced resistance mechanisms of plants

Steffen Hagenbucher[1], Michael Eisenring[1], Michael Meissle[1], Jörg Romeis[1]

[1]Agroscope, Institute for Sustainability Sciences, Zürich, CH, steffen.hagenbucher@agroscope.admin.ch

Insect-resistant transgenic plants are grown on millions of hectares worldwide. The most common of these plants express insecticidal Cry proteins from the bacterium *Bacillus thuringiensis* (Bt), which are highly selective against certain types of insect herbivores. While we do understand their direct impact on insect herbivores quite well, our knowledge about indirect interactions between the plant, the Bt-trait, and insect herbivores is still scarce. The most likely way the Bt-trait could affect indirect interaction webs is via influencing the plant's natural insect-resistance mechanisms, e.g. by reducing damage caused by the target herbivores. This could lead to an decreases expression of inducible resistance traits, making the plants more vulnerable against other herbivores. However, if the Bt-trait has an influence on plant resistance this interaction would be bidirectional. For example, induction of resistance traits could weaken the transgenic resistance by competing for the same resources. On the other hand, induced resistance could improve the efficacy of the Bt-trait by acting synergistically, or by providing resistance against herbivores that are not affected by Cry proteins, thereby delaying the development of resistance. Understanding these mechanisms could be of importance to improve the control of such herbivores or in the management of resistance development against Bt.
We are conducting a study to further improve our knowledge about these important interactions. We choose Bt-cotton plants (*Gossypium hirsutum*) expressing two Cry proteins (Cry 1Ac and Cry 2Ab) as our model plants. These plants will be induced and changes in the composition of important defense compounds will be measured (ELISA, HPLC) to describe the interactions between the Bt-trait and induced insect resistance. Additionally we will conduct a range of feeding assays to detect if interactions between resistance traits are affecting herbivorous insects. These studies will be conducted using larvae of the polyphagus, multivoltine moth *Spodoptera littoralis*. These animals are of high economic importance for a wide range of crops and are not strongly affected by the Bt-trait and therefore need additional management methods.

P5 - On the effect of environmental filtering versus neighbourhood effects for intraspecific trait variability

Susanne Tautenhahn[1], Christina Grün-Wenzel[1], Steve I. Higgins[2], Anna Golinko[1], Christine Römermann[1]

[1]Plant Biodiversity Group, Institute of Special Botany, FSU Jena, Jena, DE, susanne.tautenhahn@uni-jena.de
[2]Department of Botany, University of Otago, Otago, NZ

There are two important mechanisms shaping intraspecific trait variation: environmental filtering and niche differentiation. Environmental filtering is selecting for individuals matching the „trait-range" providing a certain environment. Within the margins set by environmental filters, individuals can modify their traits in response to their nearest neighbors via competition or facilitation effects, which leads to niche differentiation.

Here, we present a framework to disentangle the effect of environmental filtering and neighborhood effects on the intraspecific trait variability – two mechanisms operating on different spatial scales.

To this end, we present a case study on five dry grassland plant species distributed across Europe. We compiled a large data set combining different data streams and covering different spatial scales.

Environmental filtering was studied on the landscape scale. We measured individual based trait distributions per species (canopy height, leaf nutrients, d13C) of 1082 individuals based on 62 populations across Europe . We compiled a large dataset on site conditions originating from field measurements, climate data and remote-sensing products. We used quantile regression to analyze which environmental factors constrain margins of trait distributions.

In a second step, we analyzed how biotic interactions and complementarity influenced intraspecific trait variability given the margins set by the environmental filtering. Additional trait measurements where taken from the four most important neighbors. We were able to show that also neighbor - traits can help characterizing niche differentiation.

P6 - Positive effects of root-knot nematodes on nitrogen availability do not outweigh their negative effects on fitness of Nicotiana attenuata

Caspar Schöning[1], Susanne Wurst[1]

[1]Freie Universität Berlin, SFB 973, Berlin, DE, caspar@zedat.fu-berlin.de

Root herbivory incurs fitness costs for plants, but herbivory by nematodes can additionally increase nutrient availability mediated by enhanced root exudation and soil microbial activity. We hypothesized that these positive indirect effects may outweigh the negative direct effects of herbivory by nematodes on plant performance. Therefore we tested the effects of short-term (3 weeks) and long-term (11 weeks) belowground herbivory by root-knot nematodes (*Meloidogyne incognita*) on the biomass, nitrogen levels, and reproductive output of *Nicotiana attenuata*, and its interaction with a specialist aboveground herbivore (*Manduca sexta*). Long-term nematode herbivory caused an increase in shoot biomass and enhanced nitrogen levels in roots, shoots and seeds, but reduced the reproductive output. Short-term nematode herbivory had only negligible effects. The interaction with *Manduca sexta* was not influenced by nematode herbivory. In summary, only long-term nematode herbivory increased nitrogen availability and caused resource sequestration to the shoots; however, this effect was not strong enough to outweigh the fitness costs of nematode herbivory.

P7 - Effects of the photoassimilate transport on the isotope signature (δ13C und δ18O) of sugars in adult European beech and Norway spruce

Sonja Blankenagel[1], Michael Goisser[1], Thorsten E. E. Grams[1], Rainer Matyssek[1]

[1]Technische Universität München, Ecophysiology of Plants, Freising, DE, sonja-blankenagel@arcor.de

There is an interest in correlating climatic conditions and related plant responses, i.e. tree ring diameter growth and their isotope signatures to improve our understanding of plants' physiological behaviour under a changing climate (Cernusak & English*,* 2015, Gessler *et al.,* 2009). However, we lack information about processes that potentially influence isotope signatures of photoassimilates beyond photosynthetic carbon isotope discrimination and evaporative oxygen isotope enrichment, e.g. during their transport in the phloem (Gessler *et al.* 2009). Therefore we examined the isotopic signal ($\delta^{13}C$ and $\delta^{18}O$) of photoassimilates in adult beech and spruce during their transport from the leaf along branches and stems to the roots. In addition, the contribution of sun and shade crowns to the isotopic signature in the stem phloem was assessed.

In spruce, $\delta^{13}C$-values of the stem phloem were the same as in current year's needles of the sun crown. Along the transport pathway in the stem, there was no significant change in the $\delta^{13}C$ signature. The $\delta^{18}O$ signature of assimilates of the basis of the sun branches was represented by the $\delta^{18}O$ signature of assimilates in the stem. It remained unascertained if there is an influence of transport on the $\delta^{18}O$ signature of spruce. In beech, both isotopic signatures in photoassimilates remained unaffected along their transport pathway from the leaf to the roots. The isotopic signatures in the stem reflected the $\delta^{13}C$ and $\delta^{18}O$ values of the sun crown.

Overall, isotopic signatures of photoassimilates ($\delta^{13}C$ and $\delta^{18}O$) in the phloem of the stem reflected the values found in sun crowns. No evidence for a modification of the isotopic signature attributable to assimilate transport was found.

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P8 - Belowground plant productivity along the flooding gradient in a salt marsh

Regine Redelstein[1], Dietrich Hertel[1], Thorsten Balke[2], Michael Kleyer[2], Christoph Leuschner[1]

[1]Plant Ecology and Ecosystem Research, University Göttingen, Göttingen, DE, regine.redelstein@biologie.uni-goettingen.de
[2]Lanscape Ecology, University Oldenburg, Oldenburg, DE

The presented study is part of the research project BEFmate (biodiversity and ecosystem functioning across marine and terrestrial ecosystems) with the aim to study BEF relations along the succession from marine (tidal flat) to semi-terrestrial (salt marsh) ecosystems. Within this project, our study focuses on belowground plant productivity which provides important information on carbon input to the sediment food web. This is assumed to be strongly dependant on the contrasting soil conditions along the flooding gradient of a salt marsh.

The investigations are conducted in the three zones of a salt marsh (pioneer zone dominated by *Spartina anglica*, lower salt marsh dominated by *Atriplex portulacoides* and *Puccinellia maritima*, upper salt marsh dominated by *Elytrigia atherica*) at two study sites along the German North Sea coast, i.e. on the island of Spiekeroog and near Westerhever. The soil substrate at the Spiekeroog site is mainly sand and fine sand whereas the soil at the mainland location near Westerhever is characterized by high proportions of clay. Total root and rhizome biomass was determined depending on soil depth by sequential soil coring for the three salt marsh zones. As it is hypothesized that in these very dynamic ecosystems the greater proportion of the total plant biomass is belowground biomass also aboveground biomass was determined along the transects at both study sites. Furthermore, minirhizotron tubes are installed at all three levels of the salt marsh and are scanned in a monthly interval during the vegetation period for direct observation of root growth and the determination of root turn over. In the further course of the project the development of belowground plant biomass on newly establishing islands will be investigated on experimental islands which are set up on the tidal flats near the island of Spiekeroog.

P9 - Biomass Allocation into different plant functional groups in oriental beech forests: the effect of different disturbance regimes

Zahed Shakeri[1], Annette Otte[2], Lutz R. Eckstein[2]

[1]Shakeri Zahed, Faculty of Natural Resources, University of Kurdistan and the Center for Research & Development of Northern Zagros Forestry, Sanandaj, IR, shakeri.zahed@gmail.com
[2]Institute of Landscape Ecology and Resource Management, Research Center for Biosystems, Land Use and Nutrition (IFZ), Justus Liebig University Gießen, Giessen, DE

Disturbance is a fundamental element to maintain structural, species and functional diversity in forest ecosystems. *Fagus orientalis* is one of the most ecologically and economically important trees of the Caspian region, Northern Iran. These valuable ecosystems are affected by different disturbance regimes including gap formation, harvesting and cattle grazing. We examined biomass allocation of seven functional plant groups (FPG) under six different disturbance regimes. Data sampling was carried out in four beech associations; Fagetum orientalis, Carpino betulii-Fagetum oientalis, Rusco hyrcanii-Fagetum orientalis and Ileco spinigiera-Fagetum orientalis and fresh biomass for FPGs were measured in 520 sample plots of 1 m^2 area. Forbs (183 gr/m^2) and legumes (0.1 gr/m^2) had the highest and lowest biomass, respectively. Nested GLM analysis revealed that disturbance regime only affected fern and shrub functional groups, whereas forest association only affected shrub functional groups biomass. Forward selection in RDA resulted in eight important variables out of 42 environmental variables. Among these relative light (light group), elevation, inclination (topography group), saturation moisture, potassium, pH (soil group), stocking rate and gap-grazing disturbance regime (disturbance group) had the largest impact on biomass allocation of FPGs. Selected variables explained 24 % of the total variation in the biomass data and partial RDA showed that disturbance, topography, soil and light group, respectively, explained 8.0, 7.4, 6.1 and 4.5 percent of the total variation (with spatial distribution as co-variable). Our result showed that disturbances like gap and cattle grazing in forest openings can significantly increase the biomass of ferns and shrubs. When soil moisture is high, ferns like *Matteuccia struthiopteris* and *Pteridium aquilinum* dominate the gaps and in drier gaps *Rubus* spp. *Crataegus* spp. and other shrubs will increase.

P10 - Allocation trade-off between root vs. mycorrhizal surface defines nitrogen and phosphate relations in 12 grassland species

Stephan Unger[1], Martina Friede[1], Janik Hundacker[1], Katharina Volkmar[1], Wolfram Beyschlag[1]

[1]Dep. for Exp. and Systems Ecology, University of Bielefeld, Bielefeld, DE, stephan.unger@uni-bielefeld.de

In oligotroph ecosystems, such as dry sandy grasslands, selective pressure for life under nutrient deficiency has promoted the dominance of plant species with efficient nutrient uptake mechanisms, like extensive and widely branched root systems. However, some prominent species only develop coarse and narrow root systems, with their successful establishment likely being related to C-allocation into arbuscular mycorrhizal fungi (AMF). A trade-off between belowground C-investment into either roots or AMF is therefore predefined in such oligotroph habitats and most probably one of the main reasons for species differing in their mycotrophy level and their responsiveness to the AMF. C-investments into AMF do not only comprise carbon allocation to the fungus, but also to root-structures, such as an extensive cortex, to allow for residence of fungal structures, thereby explaining the coarse root systems of many mycotrophic species. Further, the C-allocation trade-off between absorptive root-surface vs. AMF-surface might bring about differential advantages related to efficient nitrogen (N) vs. phosphorous (P) nutrition, and thereby may explain the occurrence of root vs. mycorrhizal strategists in habitats with diverse nutritional conditions. We investigated mycorrhizal responsiveness together with root morphological characteristics and plant P- and N-relations in 12 grassland species. We found strong correlations of fine-root proportions and root cortex thickness with mycotrophic degree. Additionally, we observed a negative correlation of plant N content and a positive correlation of plant P content with mycotrophic degree over the 12 species. These results strongly confirmed our hypotheses regarding the relevance of the carbon-allocation trade-off between root vs. mycorrhizal surface for efficient N- and P-nutrition in grassland species, with this trade-off potentially having direct consequences for competitive interactions and the occurrence of root vs. mycorrhizal strategists over the course of succession.

P11 - The Spatial Turnover of Species, Phylogenetic and Functional Diversity in a Subtropical Forest Chronosequence

Xiangchng Mi[1], Nathan Swenson[2], Gang Feng[1], Qi Jia[3], Mide Rao[1], Haibao Ren[1], Daniel Bebber[4], Keping Ma[1]

[1]State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, Beijing, CN, mixiangcheng@ibcas.ac.cn
[2]Department of Plant Biology, Michigan State University, East lansing, US
[3]College of Chemistry and Life Science, Zhejiang Normal University, Jinghua, CN
[4]Earthwatch Institute, Oxford, UK

Deterministic, stochastic processes and their interaction jointly influence the community dynamics of secondary forest succession. It is expected that the functional or phylogenetic community composition will converge but stochastic processes and historical contingencies will prevent convergence of the species composition. It becomes imperative to integrate species, functional and phylogenetic beta diversity approaches into a theoretical framework to understand the multiple facets of community assembly over succession. In this study, we developed a framework to integrate information from species, functional and phylogenetic beta diversity to infer the relative roles of deterministic and stochastic processes during secondary forest succession. We applied this framework to asubtropical forest chronosequence in east China. We found divergence in species composition but non-significant variation in phylogenetic and functional turnover over succession. This pattern suggested a dominance of stochastic assembly in this subtropical forest. At the same time, we also found few patterns of significant increases or decreases or significant deviation from random expectations in phylogenetic or functional beta diversity for different size classes over succession, providing weak evidence of deterministic processes.

P12 - Landscape characterization by functional signatures

Johannes Schmidt[1]

[1]Karlsruhe Institute of Technology (IfGG), Karlsruhe, DE, johannes.schmidt@kit.edu

Aims: The use of plant functional types (PFT) could help to reduce complexity and increase generality of observations. Applied to local vegetation, it puts different areas on equal footing and allows for comparisons. We propose to use Grime's concept of CSR-strategies for a comparison between areas and for tracing changes in these areas. By using remote sensing, CSR strategies could be mapped. Based on the modelled values we want to create a functional signature of the landscape which offers the ability for direct comparisons.

Location: The heath landscape "Oranienbaumer Heide", Saxony-Anhalt, Germany

Methods: By combining field samples and remote sensing, Schmidtlein et al. (2012) showed how to map CSR strategies. We applied this approach in a larger and more heterogeneous area. The study area was separated in sub regions which represent similar landscapes in different successional stages. Thus we enable the comparison of different functional signatures. Therefore the modelled data was assigned to the ternary feature space ('CSR fingerprint') in each case.

Results: The regression models delivered satisfying results. Areas affected by grass encroachment showed the highest competitiveness. *Calluna*-dominated vegetation was characterized by medium values for stress tolerance and competition. The meadows with sparse growing grasses represent stress-tolerating vegetation which is less competitive. Ruderality is low in the whole area. The findings from the maps were also reflected in the functional signatures. As *Calluna* dominates, the core areas within the CSR-triangle were located around the 'SC' and 'SC/CSR' strategies. Minor deviations between the subareas were reflected by different shapes of the fingerprint, varying from tendencies to the 'C/SC'-type to the 'S'-corner.

Conclusions: We were able to apply the method of mapping plant functional types on the landscape scale. Moreover, we could illustrate functional signatures. Hence, Grimes proposal to describe certain units of vegetation within the CSR-ternary could be combined with the benefits of remote sensing. By deriving CSR-signatures for different areas, we showed that differences in vegetation composition are displayed in the plant functional fingerprint. This approach provides a simple but universal feature space for baseline mapping. Besides comparing different areas, it allows to detect relevant processes in changing fingerprint over time.

P 13 - Linking plant traits to ecosystem processes in a willow biomass production system (ECOLINK-Salix)

Friderike Beyer[1], Petra Fransson[1], Stefanie Hoeber[1], Martin Weih[1]

[1]Swedish University of Agricultural Sciences, Uppsala, SE, friderike.beyer@slu.se

Enhancing positive environmental impacts that are conducive to maintaining ecosystem functions are a main challenge in establishing sustainable crop systems. *Salix* is an energy crop with favorable energy balance and high production potential in many parts of the world. Cultivation of*Salix* has been shown to enhance ecosystem services. Breeding programmes are under way to improve productivity of *Salix* through selection and modification of desirable traits. At present, we have a poor understanding of how individual genotypes of an energy crop like *Salix* added to an ecosystem create, maintain, and change biological diversity and ultimately affect ecosystem processes relevant for productivity, nutrient cycling and carbon sequestration. Additionally, data on diversity effects of different *Salix* genotypes planted in mixture are lacking. We explore how the heritable traits of *Salix* genotypes affect (1) the diversity and function of understory vegetation; (2) the abundance and structure of associated mycorrhiza communities; (3) the action of herbivorous insects; and ultimately (4) ecosystem productivity and soil carbon (C) sequestration, of particular interest for climate change mitigation. The experimental sites were established in spring 2014 at three locations representing a climatic gradient from Uppsala (Sweden) to Rostock (Northern Germany) and Freiburg (Southern Germany) (www.slu.se/ecolink-salix). Four Salix varieties with known characteristics and taxonomically differently related (full siblings to different species) were planted in all theoretically possible combinations, i.e. plots with single varieties and mixtures of two, three and four varieties. The experiments are part of TreeDivNet, a worldwide platform of ecosystem research in tree diversity experiments (http://www.treedivnet.ugent.be/). Apart from a better understanding of the functional links between individual plant traits, diversity effects of crop mixtures and ecosystem processes, the gained knowledge will help us to evaluate the consequences of introducing new plant genotypes with different characteristics into biomass production systems. This research has implications for future bio-energy concepts, because new genotypes of energy crops generated by plant breeding must comply with the sustainability requirements for a carbon-neutral and environmentally friendly energy source.

P14 - Spectral responses of leaf surface traits of Aizoaceae

Rene Heim[1]

[1]Universität Hamburg, Hamburg, DE, rene.h.j.heim@googlemail.com

Plant functional traits are measurable features of individual plants. They can be morphological, physiological or phenological. Correct interpretation of traits can give proof about plants strategies to survive in different ecosystems. However, until today few studies have been conducted asking whether plant functional groups can be distinguished based on the spectral response of their leaf morphological characteristics.

The family Aizoaceae has been chosen for this thesis because they possess highly varying leaf epicuticular traits (bladder cells, hairs, rough texture, smooth texture and waxes). It was evaluated if and to what quality Aizoaceae can be classified by the spectral responses (between 400 nm and 2400 nm) of their epicuticular traits. The performance of three classifiers such as, partial least square (PLS) -, linear (LDA) - and quadratic discriminant analysis (QDA) was compared. Also, it was tested if a pretreatment with a standard normalized variate (SNV) transformation and a principal component analysis (PCA) improves the classification. For the PLS, the important variables for the projection (VIPs) were interpreted to reveal the most important features for the classification.

Results showed that four of five epicuticular traits could be classified well due to their spectral properties. The interpretation of the VIPs detected seven spectral regions that contained important information for the classification of the five functional groups.

QDA turned out to be successful nine times and PLS one time from the ten out of 50 best results. This thesis found, besides the four new established functional groups, six new spectral regions of interest due to the interpretation of the VIPs. One functional group, the group “smooth”, couldn´t be confirmed spectrally.

P15 - Characterizing of alluvial forest gaps using Airborne Laser Scanning data

Katalin Varga[1], Lothar Eysn[2], Balázs Deák[1], Cici Alexander[1], Hermann Heilmeier[1]

[1]TU Berakademie Freiberg, Institute of Biosicences, Biology/Ecology Unit, Freiberg, DE, varg.kata@gmail.com
[2]TU Vienna, Department of Geodesy and Geoinformation, Research Groups Photogrammetry and Remote Sensing, Vienna, AT

Airborne Laser Scanning (ALS) data are powerful tools to survey and analyze canopy gaps and let us characterize more accurately the status of the canopy and the understory in the gaps on large scales. Gaps have an important role in the structure and the ecological processes of forests. Furthermore they are a characteristic feature of forest dynamics and offer many niches for invasive species. The objective of our study was to survey and quantify the gaps and their characteristics in an alluvial forest associated with the Tisza Lake (Hungary) from ALS data. In the study area the gaps are formed by large fallen trees and management activities and are often colonized by invasive species. Therefore the major emphasis of our study was on the identification of the most susceptible gaps with respect to invasion by exotic species, considering forest structure complexity. At first we detected the gaps in the canopy at the leaf-off (March) and leaf-on (July) season and analyzed the gap structure and connectivity. The relevance of gap size, shape complexity, vegetation height and gap vertical structure was analyzed with respect to colonization by the most frequent invasive species *Acer negundo*, *Fraxinus pennsylvanica* and *Amorpha fruticosa*.

P16 - Plant life in winter - increasing public understanding of winter ecology

Helena Åström[1], Timo Saarinen[1]

[1]University of Helsinki, Helsinki, FI, helena.astrom@helsinki.fi

Northern plants are adapted to a seasonal climate, which is characterized by relatively short summers and long, cold winters. Winter has been regarded as a “dormant season” with little if any biological activity. However, several recent studies have shown that winter is an essential period for many ecological processes, and that climatic conditions during winter can have a major impact on the growing season. The aim of this educational project is to enhance recognition of winter processes on university-level ecology courses, and to increase public awareness of the importance of winter ecology.

To this end, we are producing concise information packages about various aspects of plant winter ecology, such as (1) winter as a part of the annual cycle of plants, (2) photosynthetic activity during winter and under snow, (3) the benefits and costs of overwintering as an evergreen, (4) winter dendrology, and (5) challenges of overwintering in a warming climate. An outline of the information packages is given in our poster. Findings of recent scientific publications are highlighted and popularized. All the educational material will be in Finnish and in Swedish and the material will be distributed through ‘Pinkka’ – an e-learning environment for species identification and biodiversity studies (www.helsinki.fi/pinkka/). The material can be used in university teaching, but it will also be freely available to e.g. teachers in secondary education, policy makers, gardening enthusiasts, conservationists and environmentalists. The project is supported by the Teachers’ Academy of the University of Helsinki.

END OF SESSION 2

Session 3 – Pattern and scale in ecology

CHAIRS: KERSTIN WIEGAND, THORSTEN WIEGAND

O1 - Patterns of small-scale functional and phylogenetic spatial structure in fully stem-mapped plots

Thorsten Wiegand[1,2], Xugao Wang[3]

[1] UFZ Helmholtz Centre for Environmental Research-UFZ, Leipzig, DE, thorsten.wiegand@ufz.de
[2] German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE, thorsten.wiegand@ufz.de
[3] State Key Laboratory of Forest and Soil Ecology, Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang, CN

Information on species traits and phylogenetic relatedness between species is now widely used to explore underlying mechanisms of vegetation assembly and dynamics. The increasingly availability of this information for fully stem-mapped plots allows for detailed analysis of correlations between spatial and phylogenetic distances of individuals, independently on the overall phylogenetic community structure. We present spatial point pattern methodology, based on the spatially explicit Simpson index, that can detect small-scale spatial phylogenetic/functional structures such as local evenness or clustering, generated by processes related with ecological similarity among species. To reveal their scale-dependent spatial footprints in local community assemblages we quantified species, phylogenetic, and functional beta diversity in two fully mapped 25-ha temperate forests and tested five competing hypotheses on the relative importance of different ecological processes (i.e., habitat filtering, dispersal limitation, and species interactions) in explaining the pattern of phylogenetic and functional beta diversity. We evaluated the match of the observed beta diversity functions with stochastic null communities corresponding to the different hypotheses. We found a clear hierarchy of scales: habitat filtering was required to place phylogenetically or functionally more similar species in the right way at larger distances (150-250m), dispersal limitation was required to produce the observed decline in beta diversity at distance below 150m, and species interactions caused small departures from functional and phylogenetic beta diversity at the immediate plant neighborhood scale of below 20m. Thus, both habitat filtering and dispersal limitation influenced the observed patterns in phylogenetic and functional beta diversity at local scales. Small-scale phylogenetic and functional relationships among plants can provide insights into the mechanisms of local community assembly.

O2 - Spatial gap analysis across biomes - from remote sensing of Namibian grasslands to drone-based applications in forests

Stephan Getzin[1], Kerstin Wiegand[2], Thorsten Wiegand[1]

[1] Department of Ecological Modelling, Helmholtz Centre for Environmental Research - UFZ, Leipzig, DE, stephan.getzin@ufz.de
[2] Department of Ecosystem Modelling, Faculty of Forest Sciences and Forest Ecology, University of Goettingen, Goettingen, DE

Gaps in vegetation may reflect processes such as competition for resources or disturbances. Often, the scales at which gaps emerge do not directly represent the interaction range of competition. In arid environments, for example, vegetation self-organization is usually the consequence of positive feedback effects operating at small scales that destabilize uniform states and lead to large-scale periodic vegetation patterns of a characteristic wavelength. The competition-induced large-scale negative feedback effects and emerging vegetation patterns such as gaps appear therefore at scales that are much larger than the range which triggers the positive feedback loop. This effect will be demonstrated based on a spatially explicit analysis of so-called 'fairy circles' in Namibia.

Scale-dependency of gap-size distributions and gap shape, however, is also of relevance in temperate forests. For example, gaps in the canopy of managed and unmanaged forests are important for controlling the recruitment of young trees and plant biodiversity in the understory. The traditional framework for studies of forests is based on schematic gap dynamics and discrete phases from gaps to mature forest where commonly only larger gaps (> 10 sqm) are considered. However, due to applications of unmanned aerial vehicles (UAVs) and very high-resolution imagery we can nowadays quantify gap sizes as small as 1 sqm and retrieve highly detailed information on gap-shape complexity, as well as on light heterogeneity. These novel insights into forest dynamics allow us new ways of inference and to formulate new ecological questions.

This talk is intended to (literally) bridge the gap between some prominent examples of vegetation gap patterns from contrasting biomes such as water-limited grasslands and temperate forests. It will briefly highlight the importance of spatial pattern analysis, scale-dependency and image resolution alike.

O3- Old dog, new tricks? Classic niche theory implemented in recent techniques for spatial analyses

Clara-Sophie van Waveren[1], Kerstin Wiegand[1]

[1] Ecological Modelling University of Goettingen, Goettingen, DE, cvanwav@gwdg.de

Population dynamics of trees are highly variable in space. Abiotic conditions, for example resource availability, and biotic interactions such as competition interact in their influence on survival and thus, occurrence patterns.

Our work aims understanding coexistence mechanisms in forests. We combine recent techniques of spatial point pattern analyses with assumptions from classic ecological theory, especially ecological niches and coexistence mechanisms.

For the analysis of spatial tree patterns we use tree data from a heterogeneous area in the National Park Hainich (Thuringia) recorded in two censuses. This dataset comprises spatially explicit information on over 15 000 individual trees from six tree species. The heterogeneity of the study area is an ideal setting for testing the importance of ecological niches for tree population and community dynamics.

To this end, we tested several ecological hypotheses on inter- and intraspecific interactions of these species, varying gradually from randomness to strict ecological niches.

Our results indicate that intra- and interspecific interaction patterns are mostly density-dependent. Spatial patterns of most species allow for different explanations regarding the importance of niche processes. However, assuming niches emphasises the repulsion patterns between the three most abundant species. Strongest intra- and interspecific repulsion patterns were evident in beech.

These results suggest that beech acts as a biodiversity repeller. Moreover, the importance of niche separation seems to depend on the number of individuals per species.

O4 - From pattern to process - confronting dynamic models to spatial forest biodiversity

Felix May[1,2], Andreas Huth[2], Thorsten Wiegand[2]

[1] iDiv - German Centre for Integrative Biodiversity Research, Leipzig, DE, felix.may@ufz.de
[2] UFZ - Helmholtz Centre for Environmental Research, Leipzig, DE, felix.may@ufz.de

A mechanistic understanding of biodiversity patterns in tropical forests still provides unresolved questions to community ecology. Processes such as dispersal limitation and negative conspecific density dependence (NCDD) have been suggested as key mechanisms for diversity maintenance, but we have still limited knowledge on the relative importance of these processes on different spatial scales. So far the detailed spatial data that is available from large forest plots has been primarily analysed with static spatial models, which can only indirectly be linked to dynamic demographic processes.

In this study we present a dynamic perspective on spatial biodiversity patterns by combining spatial data with a dynamic and spatially-explicit forest model. The model can represent pure neutral dynamics, but is also able to accommodate species differences in dispersal and in NCDD. We parameterized the model using approximate Bayesian computation (ABC). In contrast to previous modelling studies we always confronted the models to several biodiversity patterns simultaneously (e.g. species-area relationship and distance decay of community similarity).

We found that the spatial biodiversity patterns can only be predicted simultaneously if the models included species-specific NCDD. This indicates that there are many species which are hardly affected by NCDD, while a few experience strong conspecific density regulation. Surprisingly, we found that NCDD significantly influenced the distance decay, but not the overall species richness. Species differences in dispersal distance had only minor influences on the investigated spatial patterns.

Our findings shed new light on the importance of density dependence and dispersal limitation in tropical forests. On a general level we suggest that the approach of combining spatially-explicit data with dynamic community models is promising for gaining further insights into the dynamics of species-rich plant communities.

O5 - Mechanisms of monodominance in tropical forests: phase transitions driven by the competition-colonization trade-off?

Martin Kazmierczak[2], Pia Backmann[1,2], José Fedriani[2,3], Rico Fischer[2], Alexander K. Hartmann[4], Michael S. Müller[2], Felix May[1,2], Franziska Taubert[2], Jürgen Groeneveld[2], Volker Grimm[1,2]

[1] iDiv, Leipzig, DE, pia.backmann@ufz.de
[2] Helmholtz Zentrum für Umweltforschung - UFZ, Leipzig, DE, pia.backmann@ufz.de
[3] Departament of Conservation Biology. Estación Biológica de Doñana (CSIC, Sevilla, ES
[4] Carl von Ossietzky Universität Oldenburg, Oldenburg, DE

Tropical forests are a prime example of highly diverse tree communities. However, within many such forests large clusters exist that are dominated by a single tree species. Often the emergence of monodominant clusters cannot be explained by site-specific abiotic factors. Various mechanisms leading to clusters have been discussed, but their relation to each other and their explanatory power are still unknown. We therefore developed a first mechanistic model to explore whether a simple colonization-competition trade-off can already lead to monodominance, i.e. species with low distance dispersal but highly competitive seedlings are candidates for developing clusters. In our model, such a species competes with a neutral community of 7 identical other species which have long distance seed dispersal and weak seedlings. We found a phase transition from spatially mixed diverse forests to a state where the candidate species outcompetes all other species, triggered by increasing relative competitive strength of the monodominant species. Such a transition occurred for all reasonable tree mortalities. This indicates that percolation theory and in particular specific spatial configurations could, in combination with colonization-competition trade-offs, provide a main mechanism underlying the emergence of mondominant clusters in species-rich tropical forests.

O6 - Influence of abiotic habitat conditions on the spatio-temporal dynamic of tidal marsh vegetation.

Jana Carus[1,2], Boris Schröder[2,3]

[1] University of Potsdam, Potsdam, DE, jana.carus@uni-potsdam.de
[2] Technische Universität Braunschweig, Braunschweig, DE, jana.carus@uni-potsdam.de
[3] Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Berlin, DE

Structure and functionality of tidal marsh vegetation are permanently subject to changes. One way to understand the processes underlying the spatio-temporal vegetation dynamic is to comprehend and reproduce general patterns of vegetation expansion and recession. In this study we try to assess how the tidal hydrodynamic in the Elbe estuary interacts with growth and vitality of the two marsh species *Bolboschoenus maritimus* and *Phragmites australis* and to find thehabitat factors that mostly influence the spatial patterns of tidal marsh vegetation. Our approach was to develop a mechanistic spatiotemporal model that is able to reproduce patterns observed in the landscape and gives therewith a key to underlying processes. To parameterize the response curves and gain information on the proposed patterns we measured a wide range of biotic and abiotic parameters in two study areas along the river Elbe. The comparison between observed patterns and patterns predicted by the model showed that the model is able to reproduce general patterns of vegetation zonation, development and growth in the tidal marsh of the Elbe. This proves that we made the right choice of model structure, included processes, parameter combination and response curves and that the model can help to understand underlying processes.Our results furthermore show, that flow velocity, inundation height and inundation duration are (in that order) important factors and that soil water salinity in brackish marsh has no effect on the growth and zonation of the two marsh species.

O7 - How do forest-structure predictors influence distribution models of epiphytic lichens with different ecological traits?

Lyudmyla Dymytrova1,2, Silvia Stofer1, Christian Ginzler1, Frank Breiner1, Christoph Scheidegger1

[1]Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf, CH
[2]M.H. Kholodny Institute of Botany, Kyiv, UA, lyudmyla.dymytrova@wsl.ch

The occurrences and distribution patterns of epiphytic lichens are not only strongly related to climatic and topographic variables but also to the characteristics of the substrate on which they grow. It is still unclear how the forest structure at the landscape scale affects species distribution models of epiphytic lichens. We hypothesize that forest-structure data are likely to improve the predictive performance of distribution models for habitat specialist lichens restricted to specific forest habitat types but they will probably not influence the models of common spe-

cies with a wide range of ecological preferences.

To test this hypothesis two techniques (the generalized linear model and maximum entropy) at different spatial scales (1 km and 100 m) were applied for 20 epiphytic lichen species with different ecological traits in Switzerland. Forest-structure predictors (based on the canopy height of forest layers) were calculated from high-resolution airborne laser scanning data. Additionally, we used topo-climatic variables as predictors.

Regardless of the resolution, both techniques applied allowed to predict successfully the occurrences of habitat specialists but the models of common lichens overall were less accurate. Small-scale forest-structure predictors significantly improved the models of rare and threatened species with specific microhabitat requirements, mainly forest lichens (*Arthonia byssacea, Bactrospora dryina, Gyalecta truncigena* and *Vulpicida pinastri*), but they did not contribute considerably to the models of common species that have a wide range of ecological preferences (e.g. *Caloplaca cerina, Physcia stellaris*, *Phaeophyscia orbicular*is and *Xanthoria parietina*). We recommend using forest-structure data to improve the predictive performance of species distribution models for threatened epiphytic lichens, most of which are habitat specialists. The inclusion of these data will allow a hypothesis-driven sampling strategy, and will thus increase the effectiveness of the field sampling needed for investigating large regions thoroughly to discover new sites of rare and threatened species.

O8 - Comparison of single- and multi-scale models for the prediction of the Culicoides biting midge distribution in Germany

Renke Lühken[1], Jörn Martin Gethmann[2], Petra Kranz[3], Pia Steffenhagen[4], Christoph Staubach[2], Franz J. Conraths[2], Ellen Kiel[5]

[1] Bernhard Nocht Institute for Tropical Medicine, Hamburg, DE, luehken@bnitm.de
[2] Friedrich-Loeffler-Institut, Greifswald-Insel Riems, DE
[3] Municipal administration, Wittstock/Dosse, DE
[4] Institute of Environmental Planning, Leibniz University of Hannover, Hannover, DE
[5] Research Group Aquatic Ecology and Nature Conservation, Department of Biology and Environmental Sciences, Carl von Ossietzky University of Oldenburg, Oldenburg, DE

This study analysed *Culicoides* presence-absence data from 46 sampling sites in Germany, where monitoring had been carried out from April 2007 until May 2008. *Culicoides* presence-absence data were analysed in relation to land cover data, in order to study whether the prevalence of biting midges is correlated to land cover data around the trapping sites. We differentiated eight scales, i.e. buffer zones with radii of 0.5, 1, 2, 3, 4, 5, 7.5, and 10 km, around each site and chose several land cover variables. For each species, we built eight single-scale models (i.e. predictor variables from one of the eight scales for each model) based on averaged generalized linear models and two multi-scale models (i.e. predictor variables from all of the eight scales) based on averaged generalized linear models and generalized linear models with random forest variable selection. There were no significant differences between performances indicators of models build with land cover data from different buffer zones around the trapping sites. However, the overall performance of multi-scale models was higher. Furthermore, these models mostly fulfilled the best performance for the different species using the index area under the receiver operating characteristic curve. However, as also presented in this study, the relevance of the different variables could significantly differ between different scales including the number of species affected and the positive or negative direction. This is an even more severe problem if multi-scale models are concerned in which one model could have the same variable on different scales but different directions, i.e. negative and positive direction of the same variable on different scales. However, multi-scale modelling is a promising approach to model the distribution of *Culicoides* species, accounting much more for the ecology of biting midges, which use different resources (breeding sites, hosts, etc.) on different scales.

O9 - Reconstructing the historical proliferation of several non-native plant species in the American North-West

Alexander Mosena[1], Thomas Steinlein[1], Wolfram Beyschlag[1]

[1] Universität Bielefeld, Bielefeld, DE, alexander.mosena@uni-bielefeld.de

While the study of the spread of alien plants is one of the most popular topics in plant sciences, research often concentrates on the underlying mechanisms of plant invasions, but often neglects the historical context of such processes. However, to fully understand future plant invasion processes, a fundamental knowledge of past invasions and plant spread patterns is crucial. A historical analysis of the proliferation of non-native plant species applying recent geographical and computational technologies has seldom been carried out on a large geospatial scale. Here we present such a study for the American North-West (British Columbia, Washington, Oregon, Nevada, Wyoming, and Utah), a region with both high human settlement activities and pronounced anthropogenic changes in plant species composition.

We analyzed herbarium specimens from the 1850s until today which were either obtained from databases from the region or digitized by hand. Using these data we created a relational database, allowing complex queries. Up until now, the database contains more than 2 million records of both native and non-native plants. Each record provides information on 17 plant properties, including collection location and date.

To minimize collection bias, we compared the 10 most frequently collected specimens of alien and native plants of the area, employing the method introduced by Delisle et al., 2003. By plotting the cumulative number of locations against time, we created invasion curves for the plant species of interest. For the native species, the curves show the spatiotemporal distribution of the sampling of herbarium specimens in general, giving an insight into the state of knowledge of plant distribution over time. The spread of invasive species is reflected by deviations from the native species invasion curves. For every year in our database, the number of locations of each exotic species was divided by the number of locations of all native species, and the obtained proportions were plotted against time, which allows identifying periods of invasiveness. Further, our database contains sufficient geographic information to create extensive historical maps of plant distribution for both native and non-native plants at the county scale.

O10 - Growing close to an adult: do abiotic conditions mask or mimic enemy pressure?

Maud Deniau[1], Vincent Jung[1], Cécile Le Lann[1], Benoît Béchade[1], Margot Brunellière[1], Freerk Molleman[1], Thibault Morra[1], Andreas Prinzing[1]

[1] UMR CNRS 6553 Ecobio/Université de Rennes 1, Rennes, FR, maud.deniau@univ-rennes1.fr

Recruitment success is low close to the adult tree, preventing local dominance of a single species and increasing tree diversity. Janzen-Connell hypothesis (JCH) explains this pattern by a high natural enemy pressure at proximity to the adult tree. However, abiotic environment could change with spatial distance to adult tree, potentially interfering with recruitment success. Therefore, we tested whether abiotic parameters could mimic or mask a Janzen-Connell effect, by establishing a unique study system based on oaks, considering multiple abiotic factors and multiple aspects of performances of seedlings, accounting also for evolutionary distance of neighbouring trees. We found that abiotic environment changes dramatically with spatial distance form adult tree and that abiotic environment changes physiological performance and survival of seedlings. The results suggest that the effect of an adult tree on recruitment is mediated by abiotic factors rather than JCH sensu-stricto, and that approaching distantly related neighbours changes these abiotic feedbacks.

O11 - Drop it like it‘s hot - influence of age, temperature and precipitation on lava flow succession of a subtropical oceanic island

Severin D.H. Irl[1], Andreas H. Schweiger[1], Samuel Hoffmann[1], Jan-Niklas Nuppenau Nuppenau[1], Manuel J. Steinbauer[1], Anke Jentsch[2], Carl Beierkuhnlein[1]

[1] Dept. of Biogeography, University of Bayreuth, Bayreuth, DE, severin.irl@uni-bayreuth.de
[2] Dept. of Disturbance Ecology, University of Bayreuth, Bayreuth, DE

On oceanic-volcanic islands primary succession is one of the major processes of species assembly and vegetation formation due to the frequent creation of sterile volcanic soils from volcanic eruptions and lava flows. Previous studies suggest that

speed and trajectory of primary succession are influenced by lava flow age, temperature and moisture availability, but also by the status of species present (e.g. non-natives, endemics, etc.). Whereas other archipelagos have been well studied (Hawaii, Azores, Mascarenes), primary succession on the Canary Islands is understudied so far. However, succession on this subtropical archipelago might show different succession patterns and trajectories due to the relative aridity of the islands compared to more tropical or temperate islands. Here, we present the first study on primary succession on lava flows from the Canary Islands using the southern part of La Palma, one of the youngest islands of the archipelago, as our model system. La Palma offers a more than 500-year-old chronosequence of historically dated lava flows, varying in age as well as in prevalent environmental conditions such as temperature and precipitation. We sampled all vascular plants, mosses and lichens in 16 m^2 plots, enabling a full assessment of succession processes. We find that species richness shows a unimodal relation with age, temperature and precipitation, and a negative linear relationship with topographic complexity. However, no clear successional groups of species composition were identified, indicating that primary succession on the Canary Islands develops by stochastic filling of additional species rather than clear successional groups, as is the case in other systems (e.g. glacier forefields). Studying primary succession on volcanic islands is not only important to identify successional patterns and processes but might also allow a better assessment of the possible existence (or non-existence) of gene flow barriers for evolutionary studies.

O12 - Contrasted responses of ground beetles (Coleoptera, Carabidae) to environmental variables in forest fragments along a macroclimatic gradient

Ludmilla Martin[1], Pallieter De Smedt[2], Brice Giffard[3], Jörg Brunet[4], Sarah A. O. Cousins[5], Marc Deconchat[3], Martin Diekmann[6], Marco Langer[8], Jonathan Lenoir[1], Vincent Le Roux[1], Jaan Liira[7], Matthias Reiche[8], Alicia Valdés[1], Monika Wulf[8], Kris Verheyen[2], Guillaume Decocq[1]

[1] FRE 3498 CNRS - EDYSAN - University of Picardie Jules Verne, Amiens, FR, ludmilla.martin@u-picardie.fr
[2] Forest & Nature Lab - Ghent University, Ghent, BE
[3] INRA - UMR 1201 DYNAFOR, Castanet, FR
[4] University of Agricultural Sciences - Southern Swedish Forest Research Centre, Alnarp, SE
[5] Landscape Ecology - Department of Geography and Quaternary Geology, Stockholm, SE
[6] Vegetation Ecology and Conservation Biology, Institute of Ecology, FB2, University of Bremen, Bremen, DE
[7] Institute of Ecology and Earth Sciences, University of Tartu, Tartu, EE
[8] Institute of Land Use Systems, Leibniz-ZALF (e.V.), Müncheberg, DE

Forest fragmentation in agricultural landscape is a major threat to biodiversity, by decreasing the size of natural habitats, isolating the fragments and consequently, altering ecosystem functions. Carabid beetles are known to be affected by fragmentation with responses varying with the spatial scale studied and species' ecological requirements. Here, we provide a unique dataset covering a broad (continental) extent with a fine grain size (forest fragments of ca. 0.5 to a few ha). We sampled 159 ground beetle species among four guilds (forest specialists, forest generalists, ubiquitous and open-habitat species) in 224 forest fragments distributed along a 2500 km-long macroclimatic gradient across the European temperate biome (7 regions from South France to Central Sweden, each including two contrasted landscapes (moderately and highly disturbed). Species composition and richness were analyzed using generalized linear models and mixed models, and fifteen environmental variables collected at three spatial scales (continent, landscape and fragment). For each landscape window, species composition dissimilarity was analyzed distinguishing the spatial turnover and nestedness components. Our results revealed that (i) regional species pool, partly determined by climate along the latitudinal gradient, was the main driver of local species richness and composition ; (ii) local drivers were important on guilds' responses whilst landscape attributes poorly explained the observed variations; and (iii) forest and non-forest species exhibited a nested pattern and a strong turnover, respectively, suggesting deterministic extinction or habitat specialization for the former and random colonization for the latter. Our results demonstrate that considering multiple spatial scales and carabid guilds is crucial to understand community patterns and managing forest fragments, to efficiently maintain biodiversity and associated ecosystem services in agricultural landscapes.

O13 - Effect of landscape composition and configuration on morphometric variability in Libelulla fulva (Odonata, Libellulidae)

H. Beáta Nagy[1], Noémi Szállassy[4], Zoltán László[2], György Dévai[5], Béla Tóthmérész[3]

[1] MTA-DE Biodiversity and Ecosystem Services Research Group, Debrecen, HU, nagy.beata@gmail.com
[2] BBU, Faculty of Biology and Geology, Cluj Napoca, RO
[3] MTA-DE Biodiversity and Ecosystem Services Research Group, Debrecen, HU
[4] BBU, Faculty of Psychology and Educational Sciences, Cluj Napoca, RO
[5] DE, Department of Hydrobiology, Debrecen, HU

Today's human landscape-use accelerates habitat fragmentation. Local populations that are unable to track effects of human-induced habitat changes are especially vulnerable. Thus, populations may become more susceptible to other negative effects. The local populations have to adapt to the changed habitats, or go extinct. Local adaptations should reflect properties of water bodies, population sizes, landscape composition and configuration. We studied the effect of landscape composition and configuration on the morphometry of *Libellula fulva* (Odonata, Libellulidae) in two sites in East Hungary. Morphometric characteristics (length of wings and abdomen) of 1300 specimens were measured during six years between 2000 and 2007. The landscape fragmentation (effective mesh size) and diversity were measured for landscapes with a series of increasing scales (circles with a radius of

200, 400, 600, 1200 and 2500 meter). Other measured variables were the population sizes, water body characteristics as creek depth and diameter. All measured environmental variables showed significant differences between the two study sites. We found significant differences in the length of wings and abdomen among specimens between the two study sites. There was no significant difference in the asymmetry of wing lengths. Our findings help us to understand in which way landscape variables affects this endangered dragonfly.

O14 - Female biased sex-ratios: scale effects reveal the importance of rarity

Zoltán László[1], Béla Tóthmérész[2]

[1] BBU, Faculty of Biology and Geology, Cluj-Napoca, RO, laszlozoltan@gmail.com
[2] MTA-DE Biodiversity and Ecosystem Services Research Group, Debrecen, HU

Life-history characteristics such as sex ratio are enormously important for the survival and dynamics of insect populations. Skewed sex ratios are adaptations to environmental characteristics on different scales, resulted in by inbreeding due to small population sizes, mating behaviour, resource limitations, and changes in density or spatial distribution. Parasitoid sex ratios are known to be strongly female biased. Host size, host density and population sizes of parasitoids are known to affect their sex ratios. But there is less information on the effects of community level characteristics as rarity or communality and phenology at a smaller scale. The larger scale effects on parasitoid sex ratios as landscape composition and configuration are of great interest since generalisations for applicability in conservation efforts is high and studies are scarce. We examined the effect of local and landscape scale environmental and also community characteristics on parasitoid sex ratios of the same tritrophic community. Three sets of characteristics on community, local and landscape scale were used to assess overall environmental effects on the sex ratios of different parasitoid species. On the community scale rarity and phenology, on local scale the size of resource amount and its density, while on landscape scale land use and fragmentation were studied as explanatory variables of the parasitoid sex ratios. We found that sex ratio is best explained by community and local scale characteristics. Besides resource amount as the most important variable, the next one was proved to be the rarity. This result supports the hypothesis involving avoidance of inbreeding by the increase of the better dispersers. Larger scale effects have no effect on sex ratios, which result supports the egg laying female decision based on resource amount when choosing the sex of the offspring. The work was supported by a grant of the Romanian Ministry of Education, CNCS – UEFISCDI, project number PN-II-RU-PD-2012-3-0065, and by TÁMOP-4.2.2.B-15/1/KONV-2015-0001.

O15 - Insect communities in urban green spaces

Hannah Reininghaus[1], Kristy Udy[1]

[1] Georg-August-Universität Göttingen, Göttingen, DE, kudy@gwdg.de

In cities urban greenspaces provide important refuges for invertebrates. Pollinators need a temporally stable source of nectar and pollen and urban green spaces, such as gardens and parks, can provide this. To understand the effects of urban greenspaces for pollinator diversity and abundance, these communities should be sampled at multiple spatial and temporal scales as processes important at different scales affect pollinator communities differently. Additionally, position in a city, whether on the edge or in the center, influences the invertebrate community present. The surrounding landscape can also alter movement patterns of invertebrates as in cities many barriers exist. We tested the importance of city size and the local surrounding landscape on community structure. We also tested if this changes with changing seasons. We found that city size and position in a city both influence pollinator community dynamics. We also found that movement through the local landscape is highly dependent on the amount and quality of the available resources. When designing urban greenspaces the structure of these should be designed in such a way as to make them dual purpose, to provide for both humans and invertebrates.

O16 - Is the generally found host specificity in vascular epiphytes a sampling artifact?

Katrin Wagner[1], Glenda Mendieta-Leiva[2], Gerhard Zotz[1,3]

[1] Carl von Ossietzky Universität, Oldenburg, DE, ka.wagner@uni-oldenburg.de
[2] Philipps-Universität, Marburg, DE
[3] Smithsonian Tropical Research Institute, Panama, PA

Vascular epiphytes are an important plant group in tropical forests. Measuring the degree of their host tree specificity is central for understanding the ecology and assessing extinction risks of vascular epiphytes. Numerous studies indicate that, while host ranges are typically unrestricted, i.e. all present tree species are inhabitable by any given epiphyte species, at least a certain percentage of epiphyte species shows host biases, i.e. the performance of a given epiphyte species depends on characteristics of the tree species. However, the prevalence of host biases is not undisputed. One reason for this is that studies investigating host specificity at the assemblage level are prone to statistical artifacts because (1) a certain number of host and epiphyte species are bound to have problematically low sample sizes and because (2) the risk of obtaining false positives may be greatly increased when performing tests for epiphyte distribution biases among all possible combinations of tree and epiphyte species. In spite of the resulting importance of replicating tests to confirm apparent association signals between host-epiphyte pairs, most assemblage-based

studies draw conclusions from single or rather small plots. Disposing of a large dataset based on two censuses (conducted 10 years apart) of an epiphyte-tree assemblage in a lowland rainforest in Panama, we assess the consistency of association signals in time. Moreover, we assess the spatial consistency of these signals by comparing subplots of the study site. The overall proportions of association signals (positive, negative and neutral) are quite stable, while there is considerable turnover of the signal type at the level of tree-epiphyte species pairs both in space and time. Thus, our results indicate that the host bias, which is generally found in assemblage-based studies, is at least partly an artifact of field sampling and data analysis.

P1 - Spatial Scaling-up of Ecological Patterns

Matthias Fritsch[1], Katrin M. Meyer[1]

[1] Department of Ecosystem Modelling, University of Göttingen, Göttingen, DE, matthias.fritsch@forst.uni-goettingen.de

Ecological patterns often require scaling-up to yield information at a scale that is appropriate for applied questions. This scaling problem was already mentioned by Levin in 1992 and still occurs in many ecological fields today. In an attempt to compile general scaling-up methods from the vast literature of the last two decades, two principal approaches were found. The first approach is to resolve a certain scale discrepancy. Here the methods are mostly mathematical and are often based on premises and contain restrictions. The second approach is to circumvent the scaling problem. Here the methods are mainly modelling or conceptual techniques. The question to answer is which approach can be used for a given scaling problem and whether they are interchangeable or can be combined. We developed a concept to answer these questions within a test environment. Ideally, this test environment generates a simple ecological pattern on a small scale while ‚knowing' the true pattern on the larger scale. Within this environment various scaling-up methods can be tested under controlled initial conditions. The result of each method can be compared to the known larger-scale pattern. Based on the specific advantages and disadvantages that are revealed during this virtual scaling-up process, recommendations for the general applicability of the methods can be derived.

P2 - Evaluating mortality patterns caused by extreme meteorological events in a primeval forest using point pattern analysis

Marco Sciaini[1], Kerstin Wiegand[1], Daniel Esser[1], Brigitte Commarmot[2]

[1] Department of Ecosystem Modelling, University Göttingen, Göttingen, DE, marco.sciaini@stud.uni-goettingen.de
[2] WSL Swiss Federal Research Institute, Birmensdorf, CH

Based on an inventory of a permanent 10 ha forest plot, the spatial point pattern of trees in the virgin beech forest Uholka in Transcarpathia, Ukraine was analyzed. Observed singular meteorological events, i.e. wet snow and storm, during the sampling time led to the assumption of a change in the mortality pattern in Uholka. We hypothesized an increased clustering for small trees and shift to regularity for larger trees at small scales. For that reason we investigated the distribution of five tree species and the spatial arrangement of several characteristics of all beech trees in 2000, 2005 and 2010. These characteristics were selected depending on their importance regarding the stated hypothesis. Here, we present and discuss the first results of our spatial point pattern analysis. The comparison between the census years showed very similar results for the spatial summary statistics. Juvenile trees were spatially clustered at small scales (up to 25 meters), whereas old trees exhibited signs of inhibition at a scale that matches the typical crown diameters. A bivariate analysis of dead and living trees showed no significant spatial patterns of mortality. Overall, this spatial structure of the forest changed only slightly between the years 2000 and 2005 and between 2005 and 2010, but no striking effect of the wet snow or storm events was evident. All findings suggest that Uholka is mainly characterized by a small-scale disturbance regime, leading to a homogeneous pattern at larger scales. A more thorough research on the mortality pattern needs to be carried out to evaluate the scale of a meteorological influence.

P3 - Small-scale soil patterns drive sharp boundaries between habitats in the arid Succulent Karoo, South Africa

Ute Schmiedel[1], Nicole Kühne[1], Alina Twerski[1], Jens Oldeland[1]

[1] Biozentrum Klein Flottbek, University of Hamburg, Hamburg, DE

Quartz fields, which are densely covered by angular quartz gravel, represent edaphically special habitats in the Succulent Karoo, a winter rainfall desert of South Africa. They are home to an endemic flora and vegetation communities that show strong species turnover at their boundaries. Our study aims to identify which abiotic variables are associated with the abrupt shift in species at the boundaries and whether these variables change as abruptly as the species composition. We studied 56 transects of 6 x 1 m² plots across eight boundary types between six different habitats. For each plot, we sampled soil pH, electrical conductivity, and the calcium carbonate content at the soil surface, as well as soil depth, plant species composition and species richness. We tested for trends in the group means of the abiotic parameters across the different boundary types with a polynomial-contrast ANOVA. Additionally, we also aggregated the three plots left (1–3) and right (4–6) of the observed vegetation boundary and tested for differences between the mean ranks of the abiotic parameters using a Wilcoxon rank sum test. All boundary types exhibited a strong trend in either soil pH and/or electrical conductivity. Only in a few cases did calcium carbonate and soil texture also vary across boundary types. The boundary types between the most acidic quartz fields and adjacent vegetation

types showed the strongest level of fidelity of species to one of the two habitat types. We discuss the influence of parent material, microtopography, climatic aridity, size of plants, and properties of winter rainfall precipitation on the abrupt difference in soil properties and vegetation patterns. By comparing the soil patterns and plant responses on quartz fields to studies of other edaphically special habitats (e.g. gypsum and serpentine), we argue that some of the morphological features of the dominant taxa (Aizoaceae lineages) may determine their success in these habitats.

P4 - Invasion biology and the dynamics of biological invasions

Christine S. Sheppard[1], Alexander Kubisch[1,2], Jörn Pagel[1], Frank M. Schurr[1]

[1] Institute of Landscape and Plant Ecology, University of Hohenheim, Stuttgart, DE, christine.sheppard@uni-hohenheim.de
[2] Institute des Sciences de l'Evolution, Université Montpellier II, CNRS, Montpellier, FR

Biological invasions are a fascinating phenomenon but also pose major threats to biodiversity and ecosystem services. Substantial research effort has been invested to explain why some introduced species become invasive. However, invasion biology has not yet been able to identify general determinants of invasion success, which led some researchers to conclude that invasions are idiosyncratic. Reviewing the literature on invasion biology, we found that although biological invasions continue to be an important research topic in ecology, the proportion of studies considering invasion dynamics was consistently low throughout the last 20 years. We argue that progress in invasion biology rests on the ability to understand large-scale invasion dynamics, that is the population and range dynamics of invaders. We considered recent progress towards a more dynamic invasion biology and identified five key challenges: to understand how demography, biotic interactions and evolution shape invasion dynamics (i) at the early stages of introduction, (ii) during invasive spread and (iii) over long timescales, using data from (iv) small-scale experiments and (v) large-scale observations. Addressing these challenges should not only help to manage biological invasions but should also contribute to a tighter integration of invasion biology with other branches of ecology and evolutionary biology.

P5 - Establishment of a barcoding in Lauraceae from the tropical Andean forests of Ecuador - towards tree community phylogeny

Esther-Marie Lintzel[1], Mona Riahi[1], Jürgen Homeier[2], David Behringer[1], Nina Farwig[1], Christina Mengel[1], Birgit Ziegenhagen[1]

[1] University of Marburg, Marburg, DE, Esther-Marie@gmx.de
[2] Georg-August-Universität, Göttingen, DE

The tropical mountain rainforests of southeastern Ecuador are part of the "Tropical Andes" biodiversity hotspot. While species richness is not suited to depicture the inherent overall diversity the analysis of phylogenetic diversity is a promising approach in species-rich ecosystems. It relies on a complete species assignment which is not trivial per se and even more in these forests where families occur such as the Lauraceae. The latter are rich in genera while some of them comprise numerous closely related species. Species assignment and deep phylogenetics have though been shown to be successful in a species-rich tree community in Panama with the help of a three-locus chloroplast DNA barcoding. The combination of a highly conserved coding locus (*rbc*L) and more rapidly evolving regions (such as part of the *mat*K gene and the intergenic spacer *trn*H-*psb*A) allowed identifying taxa from the family to species level.

The present study is establishing this three-locus barcoding on a small set of leaf samples from herbarium specimens obtained from an altitudinal gradient. First, specimens morphologically assigned to various genera and if available to the species-level originating from the Lauraceae will be barcoded and a phylogeny be constructed. The genus *Ocotea* with numerous species is focused on because there are many morphologically similar and still undescribed taxa. Next, not-assigned samples will be tried to get re-identified either on the beforehand sequenced assigned samples or on elsewhere available sequences. Technical optimization and sequence information will be fed into a best standardized tree barcoding procedure for later on enlarging the sample size and to ultimately provide a tree community phylogeny of the hotspot. First results will be discussed.

P6 - Niche breadth estimates derived from species co-occurrence and geographic distribution: How well do they match across spatial scales?

Stephan Kambach[1,2], Jonathan Lenoir[10], Erik Welk[1,3], Gunnar Seidler[1], Jens-Christian Svenning[4], Stefan Dullinger[5], Harald Pauli[5], Wolfgang Willner[6], Antoine Guisan[7], Pascal Vittoz[7], Thomas Wohlgemuth[8], Niklaus Zimmermann[8], Jean-Claude Gégout[9], Guillaume Decocq[10], Helge Bruelheide[1,3]

[1] Martin-Luther University Halle-Wittenberg, Halle, DE, stephan.kambach@ufz.de
[2] Helmholtz Centre for Environmental Research - UFZ, Halle, DE, stephan.kambach@ufz.de
[3] German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE
[4] Aarhus University, Aarhus, DK
[5] University of Vienna, Vienna, AT
[6] Vienna Institute for Nature Conservation and Analyses, Vienna, AT
[7] University of Lausanne, Lausanne, CH
[8] Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Birmensdorf, CH
[9] Laboratoire d'Etude des Ressources Forêt-Bois (LERFoB), Nancy, FR
[10] Jules Verne University of Picardie, Amiens, FR

Habitat specialists, in contrast to generalist species, exhibit a small niche breadth, e.g. they grow only under a restricted set of environmental conditions, and are considered particularly vulnerable to changing climates. Large vegetation databases offer the potential to simultaneously estimate the niche breadths of a large number of plant species. However, these databases usually only cover a fraction of the included species' global distributions and environmental conditions. Whether niche breadth estimates calculated from such vegetation databases still offer good proxies of species niche breadths and range sizes on the global scale still remains to be tested.

We therefore estimated the realized niche breadth for more than 300 non-woody plant species that are widely distributed throughout the Alps according to the European Alps Database. Niche breadths were estimated with two approaches: i) based on abiotic conditions of species occurrences (e.g. a regional climate envelope approach) and ii) based on biotic conditions (e.g. on regional species co-occurrences). We furthermore calculated species global niche breadths (global climate envelope) and global range sizes based on range maps that were compiled in the Chorology Database Halle, comprising a large fraction of the Central European flora.

We found a moderate correlation between the two 'regionally' derived niche breadth estimates (Kendall's τ= 0.2885). Both, the regional climate envelope and the regional co-occurrence-based approach yielded only weak correlations with species global niche breadths (τ= 0.11 and 0.12 respectively) and global range sizes (Kendall's τ= 0.18 and 0.13 respectively). We conclude that the use of even large vegetation databases can still lead to misclassifications regarding habitat specialist and generalist species. We advise to a take species global distribution into account when estimating a species niche breadth and vulnerability to climate change.

P7 - Insect communities in urban gardens

Hannah Reininghaus[1]

[1] Georg-August-Universität Göttingen, Göttingen, DE, hannah.reininghaus@agr.uni-goettingen.de

In cities urban gardens provide important refuges for invertebrates. Pollinators need a temporally stable source of nectar and pollen and urban gardens can provide this. The many barriers present, such as roads and buildings, limit movement of pollinators through cities. We tested how the surrounding landscape influences health and both local and long-range movements of bumblebees. The landscapes tested were agriculture land, farmhouses, villages and cities. Dye was applied to bumblebee nests to determine local movement and pollen samples were analyzed to determine if any long-range movement occurred. We found that local and long-range movement strongly depended on the availability of resources, their quality and also on the surroundings. We also found that movement of bumblebees in cities was restricted. Bumblebee health, and that of other pollinating invertebrates, is strongly dependent on the available resources. Therefore, to sustain pollinator populations in urban areas consideration needs to be given to the spread and quality of the resources present.

P8 - Seedlings: where should you grow?

Maud Deniau[1], Vincent Jung[1], Cécile Le Lann[1], Freerk Molleman[1], Thibault Morra[1], Andreas Prinzing[1]

[1] UMR CNRS 6553 Ecobio/Université de Rennes 1, Rennes, FR, maud.deniau@univ-rennes1.fr

Understanding mechanisms underlying the spatial pattern of tree recruitment in forest remains a major question. Due to gravity, most descendants remain proximate to the mother tree. This concentration of offspring near the mother tree increases competition and exchange of enemies among seedlings, as suggested by Janzen and Connell (1970, 1971). But, is there also an advantage for offspring to be proximate to the mother tree? Specifically, offspring close to the mother tree may profit from (1) more mutualists support; (2) a more favourable abiotic environment. Moreover, (3) the increased enemy pressure close to mother may diminish if the mother is surrounded by phylogenetically distant species, as such phylogenetic isolation decreases enemy load of the mother. We conducted a field experiment in a forest on 20 oaks (*Quercus* spp.) located along a gradient of phylogenetic isolation and we studied the performance of seedlings arranged at different distances from each mother tree. Fungi were excluded by fungicide and microenvironments were measured (floristic composition, litter, microclimate, soil). We find that budburst of seedling is earlier near the mother tree and herbivory is lower. Both effects disappear after exclusion of fungi which hence act as mutualists in proximity of the mother. Moreover, these relationships disappear with phylogenetic isolation of the mother tree from its neighbours. Overall, understanding mechanisms underlying the spatial pattern of tree recruitment cannot be limited to the study of enemies, but needs to take into account many other factors.

END OF SESSION 3

Session 5 – Remote Sensing and Biodiversity Assessment
Short title: BioSens

CHAIR: BARBARA KOCH

O1 - Airborne Laser Scanning and biodiversity in forests

Jörg Müller[1]

[1] TU München, Freising, DE, joerg.mueller@npv-bw.bayern.de

Estimating biodiversity in complex habitats, particularly in forests, is still a major challenge for ecologists and conservationists. In ground-breaking work, Robert MacArthur and his colleagues quantified relationships between bird and vertical vegetation diversity, and found that the diversity of vegetation structure strongly influenced bird species diversity. However, they were limited in spatial extent when describing vertical vegetation structure due to the labor-intensive nature of data collection. Current remote sensing techniques, such as LiDAR, can describe ecologically relevant measurements of forest structure across broad extents, and thus, there are increasing efforts to examine relationships between LiDAR-derived data and patterns of animal biodiversity. LiDAR-based data have been utilized for silvicultural assessments for over a decade, but LiDAR use in biodiversity studies is more recent. LiDAR data can assist in the assessment of local animal diversity across taxa, and might assist in larger scale biodiversity assessments in remote and rugged environments. Here discuss the role of vegetation structure in biodiversity studies, followed by a description of the variables that are most commonly used in biodiversity studies. Then an overview of biodiversity studies that have utilized LiDAR in forests to date is given. I conclude with examples which might stimulate future directions concerning biodiversity assessments in forested systems that might benefit from the use of LiDAR-based data.

O2 - Tropical tree species richness across a bioclimatic gradient in Panama using airborne imaging spectroscopy

Ben Somers[1], Gregory P Asner[3], Roberta E. Martin[3], Christopher B. Anderson[3], David E Knapp[3], S. Joseph Wright[4], Ruben Van De Kerchove[2]

[1] Division Forest, Nature & Landscape; KULeuven, Leuven, BE, ben.somers@ees.kuleuven.be
[2] Flemish Institute for Technological Research, Mol, BE
[3] Carnegie Institution for Science, Stanford, US
[4] Smithsonian Tropical Research Institute, Ancon, PA

Using imaging spectroscopy we peformed a top-down mesoscale analysis of tropcial tree species richness across a bioclimatic gradient in Panama. The expressed pecipitation gradient across the Panamian isthmus makes an excellent study area for performing a mesoscale assessment of climate effects on tropical tree species richness. We used spatial patterns in local spectral variability (expressed as the Co-

efficient of Variation) and spectral similarity (expressed as the Spectral Similarity Index) as proxies for species area cuves and species distance decay curves. Results revealed significant spectral changes along the precipitation gradient. Highest spectral divesity was observed for miost forest sites while lowest diversity was observed for the driest forest sites. Most of the spectral variation came from changes in the visible (VIS) and shortwave-infrared (SWIR) reflectance. Variation in the VIS was significantly highe for the dry compared to the moist and wet forests. The oppposite was true for the NIR and SWIR reflectance. our spectral mesoscale analysis extends previous results suggesting that niche differentiation with respect to soil water availability is a direct determinant of both local- and regional-scale distributions of tropical trees.

O3 - Any theories for remote sensing of biodiversity lately?

Jens Oldeland[1], Rasmus Revermann[1], Manfred Finckh[1]

[1] University of Hamburg - Biocentre Klein Flottbek, Hamburg, DE, jens.oldeland@uni-hamburg.de

Remote sensing is a pretty applied and technical science. Complicated and expensive optical sensors carried by satellites or airplanes measure reflectance signatures of objects in a landscape. These object backscatter sunlight - image data is created. Sensor technology constrains the ability to "see" objects - there is little room for theory here. In contrast, biodiversity is a multifacetted concept fully packed with (mys)theory. Even today, ecologists have not agreed how to best quantify biodiversity given its sheer complexity. Linking biodiversity measurements with remote sensing data thus offers plenty of possible combinations of parameters, however, few theories exist until today that give a solid basis why reflectance and biodiversity should show a relationship and even fewer theories have been tested on a variety of datasets. In this presentation, I will give an overview on several hypotheses linking remote sensing and biodiversity. I will provide case studies for two specific hypotheses, a) the spectral variation hypothesis (SVH) and b) the diversity-productivity relationship. For both theories, I will provide case studies from southern and northern Africa and from Central Europe. My presentation concludes with an outlook for potential new hypotheses to be considered in the development of theories linking remote sensing and biodiversity.

O4 - Prediction of fine-scale plant diversity in grasslands using airborne hyperspectral measurements

Thomas Möckel[1,2,3], Jonas Dalmayne[2], Honor C. Prentice[3], Karin Hall[2]

[1] University of Kassel, Department of Grassland Science and Renewable Plant Resources, Kassel, DE, Thomas.Moeckel.Sci@gmail.com
[2] Lund University, Department of Physical Geography and Ecosystem Science, Lund, SE,

Thomas.Moeckel.Sci@gmail.com
[3] Lund University, Department of Biology, Lund, SE, Thomas.Moeckel.Sci@gmail.com

Many European grasslands harbour high fine-scale species diversity and thus are of particularly high conservation value. Ongoing agricultural intensification and abandonment severely threaten these ecosystems and lead to a high degree of grassland loss. As a consequence, mapping and monitoring grassland biodiversity became a major conservation priority in the European Union. Field surveys of grassland plant communities are time-consuming which is limiting the spatial extent on which they can be carried out. Remote sensing has the potential to support field-based sampling by steering sampling efforts toward grassland sites most suitable for a particular research aim (e.g. sites with a particularly low or high diversity). We examined whether aerial hyperspectral (414–2501 nm) remote sensing can be used to predict fine-scale plant species diversity in dry grazed grasslands. Vegetation field surveys were conducted on the Baltic island of Öland (Sweden). Two different modelling approaches were used to evaluate the ability of the airborne spectral measurements to predict within-plot species diversity: 1) analysing reflectance information directly in a partial least squares regression model (direct approach), and 2) using a measure of spectral heterogeneity, based on the mean distance to the spectral centroid in an ordinary least squares regression model (indirect approach). Species diversity was successfully predicted by the direct approach with a prediction error of about 20% but not by the indirect approach. Wavebands sensitive to plant pigment content (400–700 nm) and to vegetation structural properties (700–1300 nm) were identified to play a major role for the prediction of plant species diversity. With hyperspectral remote sensing technology we successfully identified fine-scale variation in grassland diversity and identified the most important drivers for the relationship. Our results stress the potential of remote sensing to map grassland diversity on large scales and to increase the efficiency of field surveys.

O5 - A remote sensing assessment of grassland degradation in a mountainous ecosystem

Martin Wiesmair[2,3], Hannes Feilhauer[4], Anja Magiera[3], Annette Otte[2,3], Rainer Waldhardt[2,3]

[2] Center for International Development and Environmental Research, Justus Liebig University, Gießen, DE, martin.wiesmair@umwelt.uni-giessen.de
[3] Division of Landscape Ecology and Landscape Planning, Justus Liebig University, Gießen, DE, martin.wiesmair@umwelt.uni-giessen.de
[4] Institute of Geography, Friedrich-Alexander University, Erlangen, DE

Grassland ecosystems are precious habitats for a wide range of organisms and contribute considerably to the Earth's biodiversity. A high grassland phytodiversity further forms diverse and stable root systems which are particularly beneficial for the erosion control for slopes of mountainous regions. Once the stabilizing root-soil aggregates are damaged, these vegetation damage spots act as starting points for erosion events. Climate change and human induced activities such as overgrazing are the decisive factors for a disruption of the vegetation cover. The Greater Caucasus ecosystem is one of the global biodiversity hotspots and land degradation has been announced as one of the main threats to its plant diversity.

The aim of our study was to evaluate the current state of grassland degradation for a highly affected region of the Georgian Greater Caucasus. We tested the normalized differenced vegetation index (NDVI) for multispectral WorldView-2 satellite data with high spatial resolution (1.8 m x 1.8 m pixel size) to estimate vegetation cover. Fractions of vegetation cover are essential indicators for the assessment of grassland degradation and have been implemented in the monitoring of arid grassland management by means of remote sensing before. We sampled plant species composition and environmental variables on 25 m² plots. Vegetation cover was derived from digital photographs and analyzed with random forest regression. Ordination and cluster analyses revealed grassland types which are restricted to different degradation stages and corresponding information on phytodiversity. Our good random forest model fit of $R^2 = 0.78$ indicates the great potential of a remote sensing approach for the small scale observation of high-montane grassland cover. We mapped grassland vegetation cover from NDVI which showed a clear separation over the full vegetation cover range for the area of interest.

O6 - Mapping the distribution of pollination types with imaging spectroscopy

Hannes Feilhauer[1]

[1] FAU Erlangen-Nürnberg, Erlangen, DE, hannes.feilhauer@fau.de

Remote sensing is increasingly used to assess functional ecosystem properties. In particular optical leaf traits such as the specific leaf area, leaf biochemistry, or structural traits that are responsible for the optical signal are frequently addressed. In contrast, our current knowledge on the potential of remote sensing to map the distribution patterns of flowering and pollination traits is very limited.

This study thus aims to answer the following questions for an extensively used mosaic of grasslands and mires in Bavaria, Germany: Is the distribution of pollination types in the study site related to optical traits that account for a characteristic spectral signature? Can we map spatial patterns of pollination types with high resolution remote sensing data?

To answer these questions, cover fractions of all occurring vascular plant species and traits related to their spectral signal were sampled in 100 plots randomly distributed across the study site. Information on pollination vectors and selfing abilities of the occurring species were extracted from the BIOLFLOR trait data base. Simultaneously, hyperspectral image data of the study site were acquired with the airborne sensor AISA Dual. Support vector machine regression was used to link the plot pollination data to the canopy spectra.

The model validation shows that the spectral signal explained up to 55% of the variation in the pollination data. In particular patterns of wind and insect pollination featured a close relation to canopy optical traits and can thus be accurately addressed with spectral data. Application of the models onto the image data allows for spatially explicit predictions that can be used to map the distribution of pollination types across the study area. The results of this study show that relations between optical and pollination traits exists and enable a detailed mapping of the related patterns.

07 - Mapping floristic gradients in wetlands using very high resolution aerial RGB imagery

Marian Koch[1], Gerald Jurasinski[1]

[1] Landscape Ecology Group, University of Rostock, Rostock, DE

Classical approaches to vegetation mapping based on remote sensing data use methods of segmentation and classification. These approaches typically produce discrete maps that assign each patch to a plant community and do not take account of continuous spatial transitions between these communities. Furthermore, many of the state-of-the-art techniques for vegetation mapping rely on multi- or hyperspectral remote sensing data. Depending on the platform used, these data are either cost-intensive for the end-user or their spatial resolution may not be sufficient for small-scale applications.

With the ongoing development of unmanned aerial vehicles (UAVs), very high resolution aerial imagery is increasingly available. However, its spectral resolution is limited, as UAV platforms typically use normal consumer cameras that deliver true color images in the RGB color space.

We assessed the potential of high resolution (down to 6cm) aerial RGB images for continuous mapping of floristic gradients in a flooded coastal fen ecosystem. Ordination space position of vegetation sampling points as well as cover values of dominant species was modeled using a moving window approach. Considering groups of neighboring pixels in the RGB image allowed for the calculation of first- and second-order textural measures as explanatory variables. Color indices derived from RGB pixels were used as further variables. We applied principle components regression to deal with the the resulting high number of variables. Cross validated modeling accuracies in terms of coefficient of determination range between 0.8 (first axis of NMDS ordination) and 0.4 (percentage cover of Schoenoplectus tabernaemontani) and significantly benefit from including textural features.

We conclude that very high resultion RGB images can be a cost-efficient alternative to imaging spectroscopy for mapping of floristic gradients in wetland ecosystems.

P1 - Mapping the yield of high mountain grassland by integrating vegetation composition

Anja Magiera[1], Hannes Feilhauer[2], Martin Wiesmair[1], Rainer Waldhardt[1], Annette Otte[1]

[1] Division of Landscape Ecology and Landscape Planning, Institute of Landscape Ecology and Resources Management, Justus-Liebig University, Giessen, DE, Anja.Magiera@agrar.uni-giessen.de
[2] Institute of Geography, Friedrich-Alexander University, Erlangen, DE

In high mountain regions, grasslands are the main fodder source for livestock and thus play an important role for the local agriculture. The accurate estimation of grassland yield is of key importance for land management in a region. However, accurately estimating grassland yield remains a challenge, especially when the data available for modelling are scarce, as it is the case in the high mountain study region Kazbegi, Greater Caucasus Georgia. Therefore, our approach aims to estimate the yield of high mountain grassland by employing the statistical relationships between biomass, vegetation composition, topography and surface reflectance.

During the summer 2014, we sampled 90 plots (á 25 m²) by using the Braun-Blanquet method to assess grassland vegetation composition (1,700 - 2,100 m a.s.l.). Samples of biomass were collected from the same plots and dried for dry matter analysis. Moreover, satellite imagery (Rapid Eye) was acquired almost simultaneously. The vegetation data was then subjected to ordination (Isometric Feature Mapping) and clustering in order to derive the main floristic gradients. A Random Forest model was used to predict and map the vegetation composition by combining topographical and vegetation indices. A second model was then used to correlate vegetation composition with biomass in order to derive the final biomass map.

The analysis of the grassland composition revealed three main grassland types: *Hordeum violaceum* hay meadows, spring pastures with *Alchemilla rigida* and *Gentianella caucasea,* and pastures with *Astragalus captiosus.* We found that the yield of these three grassland types differs in biomass. Hence, the biomass map is able to depict the gradual change of grassland yield. In preliminary modelling the predicted standing biomass (Dry Matter) varied between 3 dt/ha and 80 dt/ha.

P2 - Mapping ecosystem services and tree diversity of urban gardens in the City of Leipzig using a hybrid remote sensing approach

Roland Krämer[1,2], Ellen Banzhaf[1], Ines Cabral[1,2,4], Rolf Engelmann[3], Jessica Keim[2], Annegret Kindler[1], Aletta Bonn[1,2,5]

[1] Helmholtz Centre for Environmental Research (UFZ), Leipzig, DE, roland.kraemer@idiv.de
[2] German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE, roland.kraemer@idiv.de
[3] University of Leipzig, Leipzig, DE

[4] Martin Luther University Halle-Wittenberg, Halle (Saale), DE
[5] Friedrich Schiller University Jena, Jena, DE

Urban gardens constitute a considerable resource for ecosystem services and biodiversity in cities. The City of Leipzig has a long-lasting tradition of allotment gardening initiated by the *Schreber* movement in the late 19th century leading to one of the highest ratios of urban garden areas among European cities (2.8% of the city area and 16 m² per citizen). We derived estimations for regulating (climate regulation, carbon cycles) and supporting (NPP, water regulation) ecosystem services and tree diversity of urban gardens in Leipzig using a hybrid mapping approach based on multiple remote sensing data sets, such as digital orthophotos (DOP), a digital terrain model, and very-high resolution multispectral images acquired by an unmanned aerial vehicle (UAV). For image processing we used object based image analysis (OBIA) and different indices (e.g., LAI, sNDVI). The remote sensing part was supported by detailed field surveys. Further, we analyzed inter-functional relationships of the urban gardens with surrounding structure types (brownfields, differentiated residential areas) through GIS analyses incorporating detailed land-cover and environmental data in order to assess climate regulation and air purification effects (e.g., cooling corridors, wind and dust mitigation) within the entire City of Leipzig. 3D-models, combined with the field surveys, were used to assess the vegetation structure, including tree diversity. An important share of our research is to detect species occurrence and thus to provide spatial information on essential biodiversity variables (EBV). We could show that a hybrid use of DOPs and digital terrain models is highly profitable for the classification of a large variety of vegetation types (trees, shrubs, grassland). By the aid of the UAV we could develop a parameter to adjust vegetation and biomass estimations previously based solely on DOPs and to enhance our knowledge on EBV. We found that urban gardens represent an important urban structure type for providing ecosystem services and tree diversity, thus supporting to the quality of life in urban areas and enhancing environmental conditions. Our work is a contribution to monitor urban green infrastructure at fine resolution, which is crucial to achieve sustainable and resilient cities, also in the light of climate change mitigation and adaptation.

P3 - Detecting Acacia longifolia in a Portugese dune ecosystem combining hyperspectral and LiDAR data with field spectroscopy

André Große-Stoltenberg[1], Christine Hellmann[2,3], Christiane Werner[3], Jan Thiele[1], Jens Oldeland[4]

[1] Institute of Landscape Ecology, University of Münster, University of Münster, DE
[2] Experimental and Systems Ecology, University of Bielefeld, Bielefeld, DE
[3] Agro-Ecosystem Research, University of Bayreuth, Bayreuth, DE
[4] Biodiversity, Evolution and Ecology of Plants, Biocentre Klein Flottbek and Botanical Garden, University of Hamburg, Hamburg, DE, jens.oldeland@uni-hamburg.de

Biological invasions are considered to be one of the main threats to biodiversity. The genus Acacia includes some of the most invasive shrubs and trees worldwide. The nitrogen-fixing Fabacea *Acacia longifolia* from Southeast Australia is invasive in coastal regions, e.g. in Southern Europe and South Africa. In southwest Portugal, protected and diverse dune ecosystems are severely affected by the invasive *Acacia longifolia*. It can be considered an “invasive engineer” in these ecosystems. To understand potential ecosystem changes on a landscape scale, and to manage and control the invader, detailed distribution data is required. In order to map the spread of *A. longifolia,* we gathered high resolution hyperspectral airborne imagery and LiDAR data along a 5 x 35km coastal strip in SW Portugal between Carvalhal and Sínes in the coastal Alentejo region. The area covers the NATURA2000 site “Comporta/Galé” and the Nature Reserve “Lagoas de Santo André e Sancha”, the latter being also protected under the RAMSAR convention. For mapping *A. longifolia* and its spatial impact using remote sensing data, we collected differential GPS ground truth data for the most common shrub and tree species as well as field spectral data on leaf and canopy level, and biomass samples to quantify biochemical properties at leaf and canopy level. Concerning the classification of the spectral data, different approaches using the full spectrum, using vegetation indices and using bands related to biochemical properties of the plant canopies will be compared using Support Vector Machines and decision tree classifiers. First analysis shows that on leaf level, *A. longifolia* can be distinguished from other native and exotic species using wavelengths related to tannin concentration. However, interannual variation, in particular in the field spectroscopy data weakens classification results. Further classification studies show promising results of distinguishing the invasive *A. longifolia* from other native and exotic species using narrowband vegetation indices based on hyperspectral data.

P4 - Linking Vegetation databases and phenological metrics of MODIS time series to predict plant species richness of the Okavango Basin

Rasmus Revermann[1], Manfred Finckh[1], Marion Stellmes[3], Ben Strohbach[2], David Frantz[3], Jens Oldeland[1]

[1] University of Hamburg, Biocentre Klein Flottbek, Department Biodiversity, Ecology and Evolution of Plants, Hamburg, DE, rasmus.revermann@uni-hamburg.de
[2] Polytechnic of Namibia, Windhoek, NA
[3] Trier University, Department of Remote Sensing, Trier, DE

The Okavango Basin is a hot spot of accelerated land use change. However, baseline information on ecosystem properties such as species density is missing for most parts of the river basin.

We present an approach on how to combine vegetation data bases and medium resolution remote sensing products to predict species density. We used two statistical modeling approaches, random forest (RF) and boosted regression trees (BRT) both assuming a Poisson distribution of the response variable. Species density was derived from 999 vegetation plots sized 20 m x 50 m covering all major vegetation units of the Okavango Basin. As predictor variables we used bioclimatic variables derived from the CRU TS2and ARC2 data sets, phenological metrics of the EVI averaged over 12 years based on MODIS imagery computed with the TIMESAT software, and three topographic attributes calculated from the global digital elevation model SRTM. All predictors were resampled to the resolution of the MODIS data of 250 m x 250 m. We tested three subsets of the predictor variables a) all predictor variables b) climate only c) only remote sensing predictors.

The models performed almost equally on the three data sets, but the resulting maps based on the modeling including climate data showed obvious artifacts. All in all, both BRT and RF were able to produce realistic maps and cross-validation confirmed good model performance. The species density maps show that the Miombo woodlands of the Angolan Highland feature the highest species density with a decreasing trend southwards. The lowest values are predicted for the Acacia communities in the Okavango Delta area.

END OF SESSION 5

Session 6 - Global change and nature conservation

CHAIRS: PD DR. THOMAS FARTMANN, PROF. DR. BRUNO BAUR, PROF. DR. MARTIN DIETERICH

O1 - Urban biodiversity: Different responses of threatened and common species to habitat size and landscape composition

Ramona Laila Melliger[1], Hans-Peter Rusterholz[1], Bruno Baur[1]

[1] University of Basel - Department of Environmental Sciences, Basel, CH, Ramona.Melliger@unibas.ch

A basic challenge in conservation biology is to understand the impact of urbanization on biodiversity. Threatened species are assumed to be more sensitive to human-induced disturbances, but their low abundance complicates extensive field surveys. In this study, we examined the effect of habitat size and landscape composition on the species richness of threatened and common species of four groups of organisms (butterflies, grasshoppers, dragonflies and plants) in the city of Basel, Switzerland. We used species inventories from the natural heritage inventory of Basel-Stadt and GIS-based habitat and landscape characteristics to examine species-area relationships and the contribution of landscape elements within a radius of 200 m on the species richness of the different taxa. The diversity of threatened and common butterflies and common grasshoppers was positively related to the area of meadows but not to the area of ruderal sites. A reverse species-area relationship was found for the species richness of threatened grasshoppers. The diversity of both threatened butterflies and grasshoppers increased with increasing percentage cover of ruderal sites within a radius of 200 m, whereas the percentage cover of agricultural land positively affected the richness of common species in both taxonomical groups. Our results showed that common and threatened species of different taxa vary in their response to urbanization. Therefore, urban planners should consider different conservational strategies for natural habitats potentially harbouring the target species but also focus on increasing the habitat quality of the close surroundings to sustain urban biodiversity.

O2 - Response of bats to landscape structure surrounding urban green areas

Wiltrut Koppensteiner[1], Marcela Suarez-Rubio[1], Alexander Bruckner[1]

[1]University of Natural Resources and Life Sciences, Vienna, AT, wiltrut.k@gmx.at

Urbanization is a major process of land-use change that results in transformation of natural habitats and landscape structure due to increasing sealed areas, higher density of buildings, and reduced green areas. Urbanization has been associated with the loss of biodiversity due to habitat loss and fragmentation; therefore, conserving biodiversity in urban areas is a pressing challenge. Different taxonomic groups are negatively affected, but the effects of urbanization on insectivorous

bats are still poorly known. In addition, the influence of different urban green areas on bat activity and species richness has not been explored. The aim of this study was to assess whether landscape structure surrounding urban green areas influences bat activity and species richness. During summer 2014, we acoustically surveyed bats at 180 points distributed in nine types of green area in Vienna and quantified landscape structure in 0.5 and 1 km radius-buffer areas. Each site was sampled three times which led to a total of 540 recording nights. Large urban green areas with a complex shape led to an increase in species richness and bat activity. In addition, water bodies, vineyards, woodlots and urban areas with less than 50% sealed land strongly influence bats. Moreover, relative building height and the extent of the foundation negatively affected species richness, whereas bat activity was influenced by the interspersion of building heights. Our results suggest that management efforts should focus on enlarging green areas when possible, maintaining or increasing diversity of land uses surrounding green areas and restricting future construction to building of similar heights next to each other and restrictions of both building heights and the extent of the foundation of buildings should be enlarged.

O3 - Does high connectivity of linear landscapes elements facilitate conservation of non-agrotolerant plant species?

Jan Thiele[1], Simon Kellner[1], Sascha Buchholz[2], Jens Schirmel[3]

[1] University of Münster, Münster, DE, Jan.Thiele@uni-muenster.de
[2] TU Berlin, Berlin, DE
[3] University Koblenz-Landau, Landau, DE

Agricultural landscapes of lowland Germany are prone to drastic decline in species richness at local to landscape scales due to intensification of land use. In the region Westfälische Bucht, Northwest Germany, most permanent grasslands have been lost in recent decades (1982: 25 %, 2009: 9 % of the open landscape) due to tilling or conversion to arable land. In consequence, there is virtually no semi-natural habitat left, except for linear landscapes elements (LLE), such as field margins, ditches and hedges. In addition, massive use of fertilizer and manure have led to very high trophic status of most parts of intensive agricultural landscapes which may further reduce plant species richness.

In this landscape setting, we studied the potential of LLE for conservation of non-agrotolerant species in relation to site conditions (productivity) and spatial configuration. We used electrical circuit theory to calculate the conductance or, inversely, resistance of LLE networks in order to assess the likelihood of dispersal and migration of species (cf. McRae 2006). Specifically, we modelled effects of nutrient status, landscape context (e.g. proportion of grasslands within 500-m-buffers around plots) and conductance of LLE on the richness and diversity of plant species in sampling plots. The models were calculated separately for different ecological groups and dispersal syndromes. The study was carried out in eight study areas (á 1 km²) within in the region Westfälische Bucht where we established a total of 100 plots (á 25 m²) in all kinds of LLE stratified according to woody components (open, shaded) and wetness (with or without ditch).

We found, for instance, that the richness of intermediate grassland species in field margins was affected neither by the proportion of grassland in the surrounding landscape nor by conductance of the LLE network. In contrast, there was a marked effect of conductance on the richness of wet grassland species in ditches. More results will be presented and implications for nature conservation and landscape management will be discussed.

McRae BH (2006) Isolation by resistance. Evolution 60: 1551-1561

O4 - Diverse effects of a seven year experimental grassland fragmentation on seven major invertebrate groups

Brigitte Braschler[1], Bruno Baur[1]

[1] University of Basel, Basel, CH, brigitte.braschler@unibas.ch

Species composition often responds with a delay to global change and the impact of a driver of global change may thus be underestimated in short-term studies. Furthermore, often the focus is just on a few well-studied groups, assuming that their response is correlated to that of other groups. We experimentally fragmented grasslands for seven years and studied the response of species richness, individual density and species composition of seven groups of invertebrates (ants, gastropods, ground beetles, orthoptera, rove beetles, spiders, woodlice). We further relate the responses to the species' body size and preference for environmental factors. Responses to fragmentation varied between groups. While spider species richness and individual density were lower in fragments, the opposite was true for orthopterans or woodlice. Within groups the effects on different species similarly varied. Species composition and β-diversity differed between fragments and control plots for some groups. Fragments of two different size classes were isolated, but size or the interaction treatment*size were rarely significant. Species with high occupancy rates in undisturbed control plots responded more negatively to the fragmentation, while species with large body size were relatively more abundant in fragments in some groups. No effect of the fragmentation was found for ants, possibly due to longer lag times than in other groups because of their long-lived colonies. However, their relative abundance in fragments and control plots was related to a species' preference for environmental factors, which were affected by edge effects. Thus ant diversity might have been affected in the longer-term. Our results show the importance of considering different groups in conservation management in times of widespread fragmentation of landscapes. While species richness may respond slowly, changes in abundance related to habitat preferences or morphology may allow insights into likely longer-term changes.

O5 - Effects of habitat fragmentation on the stem increment and regeneration in the Mongolian forest-steppe

Elmira Khansaritoreh[1], Choimaa Dulamsuren[1], Christoph Leuschner[1], Markus Hauck[1]

[1] Department of Plant Ecology and Ecosystem Research, University of Göttingen, Göttingen, DE, ekhansa@gwdg.de

Growth and regeneration of Siberian larch (Larix sibirica) in a series of differently sized forest patches in the central Mongolian forest-steppe (Tosontsengel, Khangai Mountains) were investigated by dendrochronological studies. Forests in the forest-steppe ecotone are naturally highly fragmented, and logging combined with grazing has even increased fragmentation.Climatically our study area has experienced marked warming at constant annual mean precipitation; moreover, summer precipitation is constant. Long-term trends in the annual stem increment were examined by establishing separate regional growth curves for trees of different age classes. Climate response of tree-ring width, missing ring frequency, the temporal course of past forest regeneration, mortality rates and logging intensity were analysed. Results show that regeneration from the largest to smallest patches has dramatically decreased and age structure has been limited to old and very old trees in the smallest patches. Climate-response analysis revealed that in smaller patches compared to larger patches stem growth in old and very old trees are more correlated to the precipitation. Regional growth curves (RGC) show that older trees grew faster than younger trees at the same cambial age. Continuous forest establishment is characteristic of the largest forest patches and confirms that only these patch sizes demonstrate real characters of the forest.

O6 - Changing rainfall regimes across global grasslands - A review of consequences on ecosystem functioning

Stephan Unger[1], Marjan Jongen[2]

[1] University Bielefeld, Bielefeld, DE, stephan.unger@uni-bielefeld.de
[2] Instituto Superior Técnico, Lisbon, PT

Grassland ecosystems worldwide provide agricultural goods and important ecosystem services. Productivity and other ecosystem processes in grasslands are, in most cases, strongly linked to the ecosystem´s water status, a factor that is predicted to experience major alterations with global climate change. Future predictions include changes in the amount, distribution, frequency and intensity of precipitation, which may have important consequences for ecosystem state and functioning. We present an analysis on the effects of experimental precipitation manipulation on plant productivity, species diversity, soil/ecosystem respiration and soil nitrogen in grassland type ecosystems over a wide range of climate types, synthesizing the results from 72 studies. To estimate the possible impact of this effect, we calculated a sensitivity index, by weighing the ecosystem parameter response to the relative magnitude of exposed manipulation. Subsequently, we evaluated the effect of aridity index (after Köppen 1923), which accounts for both temperature and precipitation, on the sensitivity index. We found that sensitivity of ecosystem processes to changes in precipitation amounts increased with aridity. In addition, ecosystem processes were more responsive to precipitation addition than to precipitation reduction. However, we did observe high resilience of grassland ecosystems to both changing precipitation amounts and variability, which may be explained by the fact that the applied manipulation scenarios often lie within the range of the natural inter-annual precipitation variability experienced by ecosystems, and by evolutionary adaptation of grassland ecosystems to these natural inter-annual differences. Long-term effects of altered precipitation regimes on ecosystem processes, i.e. by changes in species composition and soil properties, are rarely covered within the timeframe of most studies and thus cannot be ruled out as a possible consequence of a gradually changing climate. We recommend future precipitation manipulation studies to aim at capturing possible long-term effects with comparable designs and standardized data compilation to facilitate inter-study comparability.

O7 - Predicting plant invasions under climate change: combining models and experiments to assess the potential spread of alien plants in New Zealand

Christine S. Sheppard[1,2], Bruce R. Burns[2], Margaret C. Stanley[2]

[1] Institute of Landscape and Plant Ecology, University of Hohenheim, Stuttgart, DE, christine.sheppard@uni-hohenheim.de
[2] Centre for Biodiversity and Biosecurity, The University of Auckland, Auckland, NZ

Climate change and plant invasions have been studied extensively as individual factors, but few studies have considered their combined and potentially synergistic impacts. This study aimed to test if climate change may provide opportunities for alien plants to expand into regions where they previously could not survive and reproduce. Using three recently naturalized plants in New Zealand from warmer native ranges as model species (*Archontophoenix cunninghamiana*, *Schefflera actinophylla* and *Psidium guajava*), we assessed their potential invasiveness under climate change. We modelled potential distributions of these three species under a range of climate change scenarios. To validate the models, we conducted field trails to test whether these alien plants performed as expected in sites of differing climate suitability (as identified by the models). Furthermore, we investigated effects of competition on closely related native species. The species distribution models indicated that the alien plants are likely to expand their range (by 2090) on average by 101% (*A. cunninghamiana*), 112% (*S. actinophylla*) and 70% (*P. guajava*). The field trials showed high performance of the alien plants in the sites identified as suitable. Plant biomass and survival generally correlated well with predicted suitability of the models. Additionally, effects of competition from the alien species under high densities were strong compared to intraspecific competition among the native species, particularly for *A. cunninghamiana*. Overall, we found strong evi-

dence of the potential invasiveness of these plants. Combining the results from climate-based models with field trials growing the alien species within and beyond predicted ranges results in more reliable predictions of potential spread. By having higher confidence in the potential risk of new invasive plants, cost-effective management actions can be taken to control alien plants at an earlier stage of their naturalization.

O8- The status of Juniperus seravschanica in Oman

Chloe MacLaren[1,2]

[1] Oman Earthwatch Programme, Muscat, OM, chloemaclaren@gmail.com
[2] Centre for Agroecology, Water and Resilience; Coventry University, Coventry, UK, chloemaclaren@gmail.com

The status of Zeravshan juniper *(Juniperus seravschanica)* in the mountains of Oman has become a cause of increasing concern to local people and researchers. Most trees are in poor condition, very few saplings can be found, and there are anecdotal reports of obvious decreases in condition over the last ten to twenty years. Several explanations were put forward to explain this decline, including grazing, overharvesting, soil disturbance, and climate change. To characterize the rate and extent of the decline of Oman's junipers, and to identify what might be causing it, a survey of tree condition and population structure was undertaken throughout the juniper woodlands of the Jebel Akhdar-Shams mountain range. This study was the first since 1996 to assess *J. seravschanica* throughout at large portion of its Oman range, and this geographic scope was essential to identifying the main threats to the juniper. The results indicate that climate change is the major driver of decline of Oman's junipers, and that the habitat suitable for their survival is rapidly shifting upwards. However, human activities are also threatening some of the last climatically suitable habitats for this iconic tree.

O9 - Arable weeds in a changing world

A. Theresa Rühl[1], Tobias W. Donath[2], R. Lutz Eckstein[1,3], Annette Otte[1]

[1] Justus-Liebig-University, Giessen, DE, theresa.ruehl@umwelt.uni-giessen.de
[2] Christian-Albrechts-University, Kiel, DE
[3] Karlstad University, Karlstad, SE

Today arable weed species are one of the most endangered species groups in Central Europe. Besides the changing land use, global climate change may present a further challenge to the adaptability of arable weeds.

In this context, we investigated the response patterns of arable weeds to changes in temperature and water availability during germination. The results revealed a distinct germination response of endangered and common arable weeds. At optimal water supply endangered species tended to germinate to a higher percentage than common arable weeds, however, this trend was reversed when water availability decreased. Thus, endangered arable weeds showed a stronger negative response to water stress during germination than common arable weeds. In addition, endangered arable species germinated in a narrower time window, e.g. shorter mean germination time and higher synchrony of germination. The endangered species go for the high risk strategy, while the more common species spread their germination over a longer time period. Therefore they are less sensitive towards short-term unfavourable site conditions and disturbances. Furthermore, based on comprehensive collection of data over a broad range of temperatures (3 – 35 °C) combined with several water potentials (0.0 – 1.2 MPa) germination response of endangered and common arable weeds could be modelled for differing climate scenarios. Because of less flexibility to decreasing water availability of the endangered species and a significant lower mean germination temperature (15.8 °C ± 0.4) compared to the common species (18.4 °C ± 0.2) one may suspect that the endangered arable weed species are more negatively affected by global warming than common species.

To set-up a conservation strategy for endangered species in the agricultural landscapes of Central Europe it has to be considered that climate change will further enhance the decline of several arable weeds initiated through land use changes. Conservation measures on landscape-scale would give arable weed species greater margins to face future climatic changes. Accessibility of suitable sites and genetic exchange between populations will enable species to adapt to climate and land use change.

O10 - Land sharing or land sparing for managed grasslands in cultural landscapes?

Nadja K. Simons[1], Wolfgang W. Weisser[1]

[1] Technische Universiät München, Department for Ecology and Ecosystem Management, Terrestrial Ecology Research Group, München, DE, nadja.simons@tum.de

Meeting both the food demand of a rising human population and conservation targets for biodiversity in agricultural landscapes, has sparked a debate on whether both demands should be targeted on the same area of land by extensive management (land sharing), or targeted on separate areas by increasing management intensity on one part and preserving natural habitat on the remaining area (land sparing). This debate is however not directly applicable to landscapes, which are dominated by managed grasslands, as those need extensive management in order to maintain biodiversity. We adapted the typical scenarios of land sharing and land sparing to managed grasslands and tested their potential impact on arthropod diversity. Based on their abundance along a land-use intensity gradient, arthropod species were grouped into 'winners' or 'losers' and it was assessed whether species would profit from land sparing or land sharing. As the optimal approach for a species can depend on the minimal land-use intensity applied, we tested a range of minimal land-use intensities. Most species were losers and most species were assigned land sparing. The number of species which were not found above a given minimal land-use intensity increased with increasing minimal land-use intensity. Our results indicate that intensification of land use in grasslands should be restricted to some areas (land sparing) rather than managing the whole area under moderate land-use intensity (land sharing) in order to protect arthropod diversity.

O11 - Populations of a shrub-feeding butterfly thrive after introduction of restorative shrub cutting on formerly abandoned calcareous grassland

Thomas Fartmann[1,2], Felix Helbing[2], Gregor Stuhldreher[2]

[1] Ecology, Department of Biology/Chemistry, University of Osnabrück, Osnabrück, DE, thomas.fartmann@biologie.uni-osnabrueck.de
[2] Department of Community Ecology, Institute of Landscape Ecology, University of Münster, Münster, DE, thomas.fartmann@biologie.uni-osnabrueck.de

Calcareous grasslands are one of the most species-rich semi-natural habitat types. However, area and species richness have considerably decreased, particularly due to the cessation of grazing or mowing. Accordingly, habitat restoration has become an important issue in the conservation of these grasslands.

The aim of this study was to analyse the role of shrub cutting as a measure to restore habitats of the target butterfly *Satyrium spini* (Denis & Schiffermüller, 1775) on formerly abandoned calcareous grasslands. We compared host plant density and occupancy, as well as egg batch density and size between cut, regularly managed and fallow patches.

In total, we counted 3,372 *Rhamnus cathartica* host plants on 17 calcareous grassland patches. On 309 (9%) of these plants, we found a total of 490 batches containing 1,168 eggs. Both *R. cathartica* and *S. spini* responded rapidly to restoration: Shrub cutting promoted the rejuvenation of the host plant, resulting in a strong population increase of the butterfly speciesfour years after shrub cutting. The density of the preferred small host plants (growth height < 130 cm), their occupancy, as well as the density and size of the batches on these plants, clearly exceeded those of small plants on fallow and even on traditionally managed calcareous grasslands.

Based on this study, we recommend shrub cutting on calcareous grasslands as both a restorative and regular management measure for *S. spini* habitats. Due to the increasing demand for fuel wood, shrub cutting in overgrown grasslands might even no longer be constrained by economic reasons.

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012 - Reintroduction of two rare plant species into steppe grasslands in Thuringia, Germany

Lisa Thill[1], Oliver Kienberg[1], Thomas Becker[1]

[1] Univerity Trier, Geobotany, Trier, DE, s6lithil@uni-trier.de

Relictic steppe grasslands in Germany are mostly isolated and often small in size. As they harbour many rare and endangered plant species, these species mainly exist in small populations.Those are often threatened by demographic and environmental stochasticity, and are therefore in danger of local extinctions even in intact habitats. In addition, the seed banks of steppe plant species may not be persistent and seed dispersal can be limited. As a result, suitable habitats cannot be recolonized and reintroductions can be appropriate and necessary measures to conserve rare species.

We carried out reintroductions of two rare and endangered plant species of the steppe grasslands (*Pulsatilla pratensis* and *Scorzonera purpurea*) in the Thuringian Basin, Germany. We asked whether reintroductions can protect these rare species, and if characteristics of source and target habitats, as well as the size of the source populations influence reintroduction success.

Around 900 juvenile plants of each species were planted out in spring 2010 (*S. purpurea*) and autumn 2011 (*P. pratensis*), respectively, and survival, flowering, and growth were monitored annually until 2014. During this time, 56 % of reintroduced plants of *S. purpurea* and 73 % of *P. pratensis* survived. Generalised linear mixed models revealed that reintroduced *S. purpurea* plants survived significantly better in dry grasslands, and that plants from small populations, as well as plants that had more leaves in the greenhouse prior to planting, had a higher chance of survival. In addition, the coverage of the moss layer and the amount of open ground influenced survival positively. In *P. pratensis* survival was positively influenced by the cover of the moss layer, but target and source habitat characteristics had no influence. Flowering rate of *S. purpurea* was influenced negatively by coverage of the herbaceous layer and positively by the size of plants prior to planting. Plants that were larger when planted out remained larger until 2014, as did plants originating from smaller source populations. In addition, plants on steeper slopes and in blocks with less herbaceous cover were also larger. *P. pratensis* flowered more often in dry grasslands than in semi-dry grasslands. In addition, flowering rate was higher and plants were larger on steeper slopes, and in habitats with low cover of litter.

The survival of more than half of reintroduced *S. purpurea* and about three quarters of *P. pratensis* demonstrate that reintroductions can be an effective measure to establish new populations of plant species to compensate for losses of populations in the past and present.

P1 - Interactive effects of climate change and land use on simulated soil water and vegetation dynamics on alpine grassland ecosystems

Sebastian Fiedler[1,2], Katja Geißler[1], Jian Ni[1,3], Ulrike Herzschuh[4], Florian Jeltsch[1]

[1] Plant Ecology and Nature Conservation, University of Potsdam, Potsdam, DE, sebastian.fiedler@online.de
[2] Biodiversity Research Group/Ecological Modelling, Freie Universität Berlin, Berlin, DE, sebastian.fiedler@online.de
[3] Potsdam Institute for Climate Impact Research, Potsdam, DE
[4] Alfred Wegener Institute for Polar and Marine Research, Potsdam, DE

Alpine grassland ecosystems of the Tibetan Plateau (TiP) are increasingly dominated by woody vegetation which is assumed to be driven by recent land use practices and climate warming. This ongoing transition leads to changes in soil moisture dynamics and a decline of important ecosystem services such as forage production due to increased unpalatable woody coverage. Better understanding the interactive effects of land use and the future climate change on vegetation dynamics is therefore crucial to sustain future diverse alpine ecosystems and services they provide. In this context, it is particularly important to determine critical thresholds of the ecosystem indicating irreversible vegetation shifts ('tipping points') and their dependence on the multiple interacting drivers.

Based on a well-established process-based ecohydrological model (EcoHyD, Tietjen et al. 2010) we untangled the interactive effects of land use intensity, seasonality, and climatic changes on shrub encroachment, forage production, and soil water availability on alpine meadows of the TiP. In a first step, we successfully validated the model against data from an alpine meadow in north-eastern TiP. In a second step, we systematically conducted simulation experiments on varying combinations of land use intensity (reflected by browsing and grazing intensity), seasonality (summer vs. winter browsing/grazing), and climate change scenarios (i.e. change in temperature, precipitation, CO_2) to explore the threshold behaviour of grassland/woodland transitions. Derived from these scenarios we are able to suggest land use options that can maintain future forage production while keeping the alpine meadow system stable.

P2 - Are stomata anatomical traits in Abies alba seedlings early-test variables for predicting drought-stress tolerance?

Annika Welzel[1], Birgit Ziegenhagen[1]

[1] University of Marburg, Marburg, DE, annika.welze@web.de

Greenhouse gas emissions have significantly altered global climate. Increasing temperatures and changes in seasonal precipitation regimes are expected. European silver fif (*Abies alba* Mill.) is highly sensitive to late frosts and dry summers. It reacts rapidly on drought stress by an early stomatal closure. Also, it was reported that there are significant differences in stomatal conductance and sensitivity to soil water deficit among silver fir seedlings from different seed families. Furthermore, in various other plant species it got obvious that anatomical traits such as stomatal size decreased and stomatal density increased with water deficit. Given that the variation of these traits should be largely explained by underlying intraspecific genetic variation they would be excellent traits in early-testing procedures. Already in seedling stages they could render predictors for an adaptive capacity towards drought-stress. In the present study we are measuring the length and the density of stomata in two-year-old silver fir seedlings which had been grown in the greenhouse. The seedlings are originating from silver fir stands in Austria with three different precipitation regimes (low, middle and high). In ongoing studies each two measurements are conducted for seedlings under short-term water saturation and under subsequent water deprivation. We hypothesize that seedlings which have derived from the stands with low precipitation will have smaller stomata and a higher stomatal density than seedlings which have derived from regimes with higher precipitation irrespectively of the water status in soil. Results will be presented and discussed against a background of water use efficiency, selective pressure and their usability in managing forest reproductive material.

P3 - The influence of neighbor competition on bud burst in Picea abies and Abies alba - an airborne laser scanning analysis

Dorothea Renken[1,2], Malika Gottstein[1], Katrin Heer[1,2], Birgit Ziegenhagen[1], Sascha Liepelt[1], Lars Opgenoorth[2]

[1] Philipps-University Marburg, Conservation Biology, Marburg, DE, renkend@students.uni-marburg.de

[2] Philipps-University Marburg, Department of Ecology, Marburg, DE, renkend@students.uni-marburg.de

Growth of forest trees is regulated by the availability of resources such as nutrients, water, space and especially sunlight. As tree competition directly affects the microclimatic conditions of a tree, it might also influence its phenology. Therefore, we examine the impact of individual tree competition on bud burst in Norway spruce and silver fir in intensive study sites in the Bavarian Forest National Park. Bud burst was monitored in spring 2014 and 2015 for a total of 200 adult trees per species. To evaluate competition among trees, we derived data on tree architecture and position from LiDAR images. For each tree, we calculated the Hegyi´s index, the crown competition index by Biging and Dobbertin, Gadow and Hui's mixed-species index as well as the intensity of sun light as described by Alisov. In addition, we determined dbh and distance between subject and competing trees in the field for ground truthing of the indices derived from the LiDAR data. We expect that high neighbor tree competition delays bud burst. This could be caused by many factors such as trees receiving less direct sunlight. First results will be presented during the conference.

P4 - Can climate warming alter side-effects of herbicides on the development of Common toads (Bufo bufo L.; Amphibia: Anura)?

Fabian Baier[1], Edith Gruber[1], Johann G. Zaller[1]

[1] Institute of Zoology, University of Natural Resources and Life Sciences, Vienna, AT, f.baier@students.boku.ac.at

Amphibians are among the most threatened animal taxa in the world. This fact has manifold reasons of which habitat loss, climate warming and pesticides are taking the biggest shares. Surprisingly, combined effects of climate change and pesticides on European amphibian species are barely studied. The topic is important indeed as it is expected that pesticide use will increase with climate warming, hence pesticide exposure of amphibians will also increase. We conducted laboratory experiments where we studied single and combined effects of climate warming and different concentrations of the globally most widely used glyphosate-based herbicide on the development of the Common toad (*Bufo bufo* L.). Common toads are the most abundant amphibian species in Europe with a broad ecological amplitude that migrate through agricultural land and are therefore exposed to pesticides.The experiments were performed on eggs (Gosner stage, GS 8) and tadpoles (GS 29) of *B. bufo* separately. The experiments were conducted using aquatic microcosms running in a 12 hrs day/night rhythm. We established two temperature levels (15°C vs. 20°C) and 5 different herbicide concentrations (0 - 4 mg a.e./L); every treatment combination was replicated 5 times. The chosen herbicide concentrations can be expected in aquatic bodies embedded in agricultural land. Parameters measured on eggs and tadpoles were mortality, development (GS), morphological alterations, water pH, concentration of dissolved oxygen and water temperature. Preliminary results suggest that herbicides have different effects on egg than on tadpole development. Moreover, herbicide concentrations seem to have different effects on the morphology and development of *B. bufo* at different temperatures. Taken together, our results indicate that risk assessment procedures of pesticide effects on non-target species should also consider climate warming scenarios.

P5- Effects of ultraviolet radiation on exotic plant species in New Zealand - An experimental approach

Maria Hock[1,2], Rainer W. Hofmann[3], Alexandra Erfmeier[1,4]

[1] Kiel University, Institute for Ecosystem Research / Geobotany, Kiel, DE, mhock@ecology.uni-kiel.de
[2] Martin Luther University Halle-Wittenberg, Institute of Biology / Geobotany and Botanical Garden, Halle, DE, mhock@ecology.uni-kiel.de
[3] Lincoln University, Faculty of Agriculture and Life Sciences, Lincoln, NZ
[4] German Centre for Integrative Biodiversity Research (iDiv), Leipzig, DE

Changing intensities of ultraviolet-B radiation on a regional scale are yet another aspect of global change, caused by anthropogenic emissions of tropospheric ozone, aerosol precursors as well as by recent air quality recovery. UV-B radiation fundamentally differs between the northern and the southern hemisphere due to human impact, but also in consequence of historical differences in overall solar radiation intensity and the solar elevation angle. Thus, exotic species originating from the northern hemisphere are exposed to higher amounts of UV-B when colonizing the southern hemisphere. This setting provides a suitable platform to study mechanisms of plasticity and recent adaptation in plant invasions. We investigated the effect of natural southern hemisphere UV-B radiation on exotic plant species of New Zealand grasslands within a multi-species common garden experiment in Lincoln, New Zealand. 28 herbaceous plant species, among them 8 species with both native German and invasive New Zealand origins were grown under 3 different UV treatments, i.e. exposure to natural UV-B and UV-A radiation, exclusion of UV-B radiation while admitting UV-A and total exclusion of both UV-B and UV-A, to quantify the extent of plastic responses and to assess whether adaptive plant responses might be involved. The experiment ran for about 4 months. We recorded growth and reproduction and collected leaf material of 490 individuals in total to determine leaf traits and compounds. Data were analyzed with general linear mixed models to test for effects of treatments and origins. In addition to species-specific differences in response to UV radiation levels, we found a significant reduction of root biomass under UV-B radiation. This contribution will present first results with a focus on the role of predisposition of German individuals to stressful UV-B environments and discuss possible local adaptation of New Zealand plants to high UV-B radiation.

P6 - Nuclear microsatellite markers for the assessment of genetic diversity in the endangered plant Trollius europapeus L.

Melanie Grün[1], Christina Mengel[1], Birgit Ziegenhagen[1], Sascha Liepelt[1]

[1] University of Marburg, Marburg, DE, Gruenme@students.uni-marburg.de

Nowadays many plant-species of wet grassland communities are threatened due to intensive agriculture and habitat fragmentation. This can lead to the isolation of populations, which may lead to the reduction of genetic diversity and increase the risk of extinction. Trollius europaeus, a herbaceous perennial of wet grassland communities has experienced a considerable decline in the last decades. Because of a specialized pollination system with flies from the genus Chiastocheta, reproduction of T. europaeus might be especially vulnerable to land-use changes. In many regions of Germany, such as in the northern Rothaar Mountains, populations of T. europaeus can indeed still be found but in many of them little or no rejuvenation is observed. This development is alarming because the reduced recruitment is leading to an over-aging of the populations and may result in their complete disappearance in the near future. In this study, we present newly developed nuclear microsatellite markers for T. europaeus, which will be suitable for the assessment of its genetic diversity and for the study of its mating system. For marker development we used a next generation sequencing approach with a genomic library enriched for microsatellite motifs. From the sequence data primer pairs were chosen and tested for amplification and polymorphism. Thus, we provide new tools for the assessment of vulnerability of populations of T. europaeus in order to explore possible reasons for its decline. As a first test of the new markers, we conducted a small study in three low mountain ranges of central Germany to assess genetic diversity within and differentiation between populations of T. europaeus. For this purpose, we collected leaves from the northern Rothaar Mountains, from the Vogelsberg and from the Rhön Mountains. First results are presented and discussed.

P7 - Translocation of rare plant species: insights from a 7-year study with Phyteuma spicatum

Annette Kolb[1]

[1] University of Bremen, Bremen, DE, akolb@uni-bremen.de

Reintroductions of native plant species and other forms of targeted species translocations have become increasingly important in nature conservation worldwide. Especially in fragmented habitats, plant species reintroductions represent an important tool for preserving or restoring plant diversity. To date, reintroduction experiments in Central Europe have largely focused on species from semi-natural open habitats such as grasslands, while species from forests have been less well studied. In this study, I followed the fate of more than 50 experimental populations of the perennial forest herb *Phyteuma spicatum*.The populations were established in 2006 and 2007, originally for a different purpose (Kolb 2008, Biol. Conservation 141: 2540-2549), by transplanting plants from one large population into forest fragments without natural occurrences of the species. Populations originally consisted of 5 or 15 adult individuals and were followed until 2014. In each year, I recorded the survival and flowering state of each original plant, and counted the total number of individuals including seedlings and juveniles in a 1m²-plot in the center of each population. About 30%of the originally planted individuals survived until 2014 (162 of 558 plants). Between 50-80% of all individuals flowered in a given year, but the majority of inflorescences were grazed prior to seed maturity. Recruitment was very low; in total, 546 seedlings were observed across populations and years, of which 22 survived and turned into juveniles. Most juveniles, however, survived only one year. Based on these first results, the populations are likely not to persist through time. Analyses of the effects of environmental conditions on plant survival and comparisons with demographic patterns observed in natural populations of the species will give further insights into the success or failure of such species translocations.

END OF SESSION 6

Session 7 - Linking network science to conservation of biodiversity
Short title: Interaction networks and conservation

CHAIRS: NINA FARWIG, CHRISTOPHER KAISER-BUNBURY

O1 - A trait-based concept for integrating the structural and functional components of plant-animal interactions

Matthias Schleuning[1], Jochen Fründ[2], Daniel García[3]

[1] Senckenberg Biodiversity and Climate Research Centre, Frankfurt (Main), DE, matthias.schleuning@senckenberg.de
[2] University of Guelph, Guelph, CA
[3] Univ. of Oviedo, Oviedo, ES

Network ecology has greatly advanced the understanding of the structural diversity of communities of interacting species. However, little advance has been made to understand the functional components of interactions between plant and animal species. We present a concept to develop the structural approaches of network theory into a trait-based framework for predicting animal-mediated ecosystem functions from biodiversity and mutualistic networks. We propose that the integration between structural and functional approaches in network studies requires the differentiation between three levels of biological organization that are determined by a sequence of processes. The levels correspond to: i) the assembly of ecological communities by environmental filtering; ii) the formation of interaction networks by the matching of co-occurring species; and iii) the quantitative and qualitative components of mutualistic interactions providing the ecosystem function. We integrate these levels in a framework that categorizes relevant species traits by the respective organizational level. The identification of relevant plant and animal traits and the trait relationships across the organizational levels provide a generic template for testing the consequences of species loss for animal-mediated ecosystem functions. Strong impacts on ecosystem functions are expected if the same traits mediate a species' susceptibility to environmental change, its matching capacity with other species and its functional importance for a specific ecosystem function. We hope that the proposed framework integrating the structural and functional components of plant-animal interactions will be useful for predicting the functional consequences of biodiversity loss.

O2 - A simple model generating realistic quantitative networks highlights sampling bias in specialization and network metrics

Jochen Fründ[1,2], Kevin S. McCann[1], Neal M. Williams[2]

[1]Integrative Biology, University of Guelph, Guelph, ON, CA, jfruend@uoguelph.ca
[2]Entomology and Nematology, University of California, Davis, Davis, CA, US, jfruend@uoguelph.ca

Many descriptors of ecological networks are directly or indirectly related to specialization, but quantification of specialization using field data is prone to sampling bias. However, the extent of sampling bias is difficult to estimate: previous studies either relied on field data where the true network structure is unknown, or they simulated sampling based on unrealistically generalized interactions.

Here, we present a quantitative niche model that generates bipartite networks with realistic and fully known structure. We used it to evaluate potential sampling biases in network metrics for a set of networks representing a wide range of specialization and network size.

Our results suggest that specialization is severely overestimated in most empirical networks and that the degree of bias depends on the true degree of specialization. Highly generalized networks had the strongest bias, which shows that commonly used null models may misrepresent bias. However, we also show that another common technique, richness estimation of interactions, may underestimate sampling effects.

Sampling sensitivity differed strongly among metrics: while some metrics were only slightly biased, other metrics may often not be meaningful because values from small samples were barely related to values from large samples of the same networks.

To integrate network analysis tools into conservation planning, more reliable quantitative methods have to be developed and sampling bias has to be considered when comparing network theory to empirical data. Our quantitative niche model may help to develop and evaluate methods to achieve this goal.

O3 - Temporal and spatial resource fluctuations rewire plant-pollinator interactions networks

Ignasi Bartomeus[1], Juan P. González-Varo[1]

[1] EBD-CSIC, Sevilla, ES, nacho.bartomeus@gmail.com

Mass flowering crops provide pulses of floral resources that can disrupt the foraging strategies of pollinator species. We show that blooming of orange trees in an agricultural mosaic in souther Spain monopolise large numbers of managed honeybees, which are attracted to the agricultural fields from the surrounding landscape. After the peak bloom, those honeybees are spilled over back to the landscape. This temporal and spatial changes on honeybee abundance has important indirect effects on wild pollinators foraging behaviour. Plant pollinator networks in semi-natural scrublands far from mass flowering crops show a natural interaction rewiring along the season, mostly driven by changes in species composition. However, when those areas are located in the proximity of orange fields, the honeybee fluctuations created a stronger interaction rewiring in the native community. In summary, we show that temporal changes in resource availability created by mass flowering crops has indirect effects on the plant-pollintor network mediated by managed honeybees. This is likely to have important repercussions on the stability and functioning of ecosystems.

O4 - Habitat restoration improves functional resilience of plant-pollinator communities

Christopher Kaiser-Bunbury[1], James Mougal[2], Andrew Whittington[3], Jens M. Olesen[4], Nico Blüthgen[1]

[1] TU Darmstadt, Darmstadt, DE, ckaiser-bunbury@bio.tu-darmstadt.de
[2] Seychelles National Parks Authority, Victoria, SC
[3] Bournemouth University, Bournemouth, UK
[4] Aarhus University, Aarhus, DK

Habitat restoration is a common tool to mitigate the loss of species and habitats, aiming to restore ecosystem functioning. Large-scale experimental evidence is lacking, however, on whether standard management techniques indeed restore ecosystem functioning at the community level. One key ecosystem function is pollination. We used an experimental network approach to test two main hypotheses: 1) habitat restoration increases the robustness of plant-pollinator networks by increasing pollinator diversity and altering pollinator behaviour; and 2) the observed structural changes in the networks enhance the functional performance of pollinators and overall plant reproductive performance. We collected 64 monthly pollination networks from four restored and four unrestored woody plant communities (each 1-2 ha) on the island of Mahé, Seychelles, over a full flowering season of eight consecutive months. Habitat restoration resulted in a prompt and marked increase in pollinator and interaction diversity. Changes in network structure indicate improved plant-pollinator community robustness in restored compared to unrestored sites. These patterns had direct and positive effects on the functional performance of pollinator and total fruit production of native plants in restored sites. The main implications of our findings are: 1) habitat restoration affects pollinators positively by changing their foraging behaviour, suggesting that degraded pollination processes are at least partly reversible; 2) Pollination network structure is directly related to the quality and robustness of pollination services; and 3) Increased relative and total fruit production in restored plant communities are encouraging indicators for a successful restoration trajectory towards self-sustaining native plant communities.

O5 - Pathogen sharing among managed and wild bees in apple orchards

Martin Husemann[1], Rita Radzeviciute[1], George Japoshvili[2], Giorgi Kirkitadze[2], Aigul Zhusupbaeva[3], Robert J. Paxton[1,4]

[1]Martin-Luther University Halle-Wittenberg, Halle (Saale), DE, martinhusemann@yahoo.de

[2]Agricultural University of Georgia, Tbilisi, GE
[3]Agricultural University of Kyrgystan, Bishkek, KG
[4]German Centre for integrative Biodiversity Research (IDiv), Leipzig, DE

In the face of biodiversity decline and the loss of pollination service in many countries, understanding the forces driving these negative trends is an important task. Besides habitat fragmentation and heavy pesticide use that have been suggested as major drivers for pollinator loss, the importance of emerging pathogens has come more and more to the fore. For honey bees, multiple viruses and other parasitic organisms have been suggested to play an important role in colony loss. Yet, little is known about the importance of such diseases for wild pollinators and the role of infected, managed honey bees for wild bee populations. Here, we address this question by studying the prevalence of 10 common bee viruses in populations of wild and managed bees in three locations in Georgia, Kyrgyzstan and Germany. We found viruses in wild and managed bee populations, with several viruses being shared between both, suggesting inter-species transfer of pathogens. Though our data cannot be used to demonstrate the directionality of pathogen transmission, they highlight how viral pathogens may infect and may be transmitted by multiple members of the guild of flower visitors.

O6 - How land-use effects spread through ecological communities: insights from coupled mutualistic networks

Jörg Albrecht[1,2], Dana G. Berens[2], Bogdan Jaroszewicz[3], Nuria Selva[1], Roland Brandl[4], Nina Farwig[2]

[1] Institute of Nature Conservation, Polish Academy of Sciences, Kraków, PL, albrecht@iop.krakow.pl
[2] Conservation Ecology, Faculty of Biology, Philipps-Universität Marburg, Marburg, DE, albrecht@iop.krakow.pl
[3] Białowieża Geobotanical Station, Faculty of Biology, University of Warsaw, Warsaw, PL
[4] Department of Ecology—Animal Ecology, Faculty of Biology, Philipps-Universität Marburg, Marburg, DE

Networks of species interactions are intimately linked to the persistence of species and to the functioning of ecosystems. Until recently, these networks have mostly been studied in isolation, but species are commonly involved in multiple, diverse types of interaction. Therefore, whether different types of species interaction networks coupled through shared species show idiosyncratic or predictable responses to habitat degradation is unresolved. We studied the collective response of coupled mutualistic networks of plants and their pollinators and seed dispersers to the degradation of Europe's last relict of old-growth lowland forest (Białowieża, Poland). We show that logging of old-growth forests had correlated effects on the interactions of plants in both mutualisms, which highlights that land-use effects on coupled interaction networks are non-idiosyncratic. Moreover, shifts in plant densities on logged sites explained about 40 to 70% of the variation in the magnitude of land-use effects on interactions of plants with animal mutualists. This implies that shifts in species' abundances are likely to amplify the magnitude of land-use effects on species interactions. Moreover, our results demonstrate that considering biotic context (e.g., resource availability) may greatly improve our ability to predict land-use effects on species and communities. The comparison of several interaction types also revealed that a high degree of generalization, such as in seed dispersal mutualisms, does not necessarily buffer ecological communities against the loss of species. This applies especially if a few species have a disproportionate effect on a given function and if these species are vulnerable to ecological perturbation, such as habitat specialists or large-bodied frugivores. Altogether, these findings emphasize that network analyses can provide the knowledge base for the identification of species or functional groups of organisms that are the keystones of ecosystem integrity.

O7 - The mobile-link function in seed dispersal networks

Juan P. González-Varo[1]

[1] Estación Biológica de Doñana (EBD-CSIC), Sevilla, ES, juanpe@ebd.csic.es

In a world dominated by human-altered landscapes, the ability of species to disperse through a matrix of anthropogenic habitats (urban and agricultural) is necessary to ensure the connectivity of their populations, the colonization of vacant habitats after disturbance, and thereby their long-term persistence in fragmented regions. A critical question for conservation is whether differences among species in dispersal translate into biodiversity loss through biotic homogenization. The ability of fleshy-fruited plants to disperse through the anthropogenic matrix relies on their capacity to interact with those frugivore species that move across its habitats providing key seed dispersal services. Organisms that connect habitats in the landscape are termed "mobile links" and are considered essential for ecosystem resilience. I analyse the mobile-link function in seed dispersal networks and its role on biotic homogenization. We have resolved seed dispersal networks using novel DNA-barcoding techniques, which are providing unprecedented information about the functional value of specific frugivore species in fragmented landscapes. Resulting knowledge can be incorporated into management and policy-making decisions for preserving woodland biodiversity in fragmented regions.

O8 - Robustness of plant-herbivore interaction networks to climate change in a fragmented forest landscape

Kevin Bähner[1], Katharina Zweig[2], Rainer Wirth[1]

[1] University of Kaiserslautern; Plant Ecology and Systematics, Kaiserslautern, DE, baehner@rhrk.uni-kl.de

[2] Network Analysis and Graph Theory; University of Kaiserslautern, Kaiserslautern, DE

Habitat fragmentation and climate change are the strongest man-made threats to ecosystems, but how they affect plant herbivore interaction networks is largely unknown, despite their paramount position in the trophic pyramid and their manifold ecosystem functions and services. We studied the robustness of such networks (overall > 600 individual interactions) from the North Palatinate highlands, SW Germany, against climate change in fragmentation-affected habitats (forest fragments and forest edges) and continuous control forests by quantifying topological network parameters associated with robustness (complexity, nestedness and niche redundancy) and by modeling climate change-based extinction scenarios.
Fragmentation-affected habitats, particularly forest edges, were coined by networks of higher complexity (Shannon diversity of interactions), nestedness, and lesser trophic complementarity (H2'), thus indicating higher stability. Consequently, modeled extinction cascades (derived from climate change based extinction scenarios) showed networks in forest fragments and edges to be more robust, whereas networks in the forest interior declined more rapidly.

We explain our results via the (i) floristic composition of forest habitats and (ii) the corresponding network topology. (i) Forest fragmentation promoted thermophilic plants and generally high plant diversity, whereas forest interior habitats harbored species-poor shade-adapted species. Hence a higher proportion of interactions was found on thermophiles in forest edges and fragments. These plants survived longer in climate change scenarios and therefore can sustain herbivore populations more reliably. (ii) Furthermore higher network complexity and trophic redundancy indicated a higher degree of overall connectivity and niche overlap of herbivores. Thus, upon loss of a host plant, herbivores were more likely to have alternative hosts that save them from secondary extinction. Based on these results we give suggestions for well-aimed conservation measures, which would have been impossible without using a network approach and without using biologically realistic extinction scenarios.

END OF SESSION 7

Session 8 - Vegetation Ecology of Drylands – Insights, perspectives, challenges

Short title: Ecology of drylands

CHAIRS: DR. JAN C. RUPPERT, PD DR. ANJA LINSTÄDTER

O1 - Encroachment of an herbaceous legume seriously affects important fodder grasses in the Pro-Namib

Thomas C Wagner[1], Christina Fischer[1]

[1] Restoration Ecology, Technische Universität München, Freising, DE, wagner@tum.de

The encroachment called shift of arid grasslands from grass dominated to shrub dominated communities is associated with serious implications for ecosystem functions and services that often resemble those of plant invasion by non-native species. Especially its mostly negative consequences for forage grasses and pastoral production have been subject to intensive discussion and led to a common negative connotation of this process. However, encroachment is usually solely associated with woody species or shrubs. Within the last decade, a native, annual herbaceous legume, *Crotalaria podocarpa*, has exhibited an extensive spread in arid grasslands in Namibia's great escarpment region and apparently repressed the formerly aspect building local grasses in large areas. To quantify the short and long term effects of the proliferation of *C. podocarpa* on the dominant perennial tussock forming forage grass *Stipagrostis ciliata* we studied *Crotalaria* and *Stipagrostis* abundance and biomass production on long-term observation plots since 2009 and investigated possible facilitation of *C. podocarpa* by *S. ciliata*. We found competition with *Crotalaria* to reduce biomass production of *Stipagrostis* individuals by 30% and to weaken the ability of *Stipagrostis* tussocks to recover after drought. *Crotalaria podocarpa* was facilitated by *Stipagrostis* tussocks but led to a continuous decrease of grass tussocks in affected areas. Our study demonstrates, that the massive spread of a native annual plant, similar to woody encroachers and invasive species, can severely affect arid grassland productivity, reduce its carrying capacity and may also affect biodiversity.

O2 - Growth and water use of trees and stands of Populus euphratica (Tarim Basin, NW-China) - effects of different groundwater levels

Petra Lang[1], Michael Jeschke[1], Philipp Schäfer[1], Ximing Zhang[2], Frank M. Thomas[1]

[1] University of Trier - Faculty VI - Geobotany, Trier, DE, langp@uni-trier.de
[2] Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi, CN

In the hyperarid Taklamakan Desert of Northwestern China, the only water sources for plants are the Tarim River water and groundwater. The riparian forests along the Tarim River (*tugai* forests), the main vegetation type of this region, are mainly

made up by the phreatophyte Euphrates poplar (*Populus euphratica*Oliv.).

Changes from traditional land use to industrialized cotton farming combined with a dramatic increase of the population within the past 60 years were accompanied by an uncontrolled overuse of Tarim River water. This resulted in a drastic decrease of the groundwater level and in the frequency of natural floods. As a consequence, the *P. euphratica* stands declined on a large scale and are now being declared as a highly threatened ecosystem.

Within the framework of the joint German-Chinese project SuMaRiO (Sustainable Management of River Oases along the Tarim River), we investigated the effects of different distances to the groundwater (small, intermediate and large) of *P. euphratica* trees and stands at two study sites: (i) Yingbazar: middle reaches of the Tarim river, groundwater distances 2.0, 7.5 and 12.0 m; (ii) Arghan: lower reaches of the Tarim River, groundwater distances 4.8, 5.2 and 6.6 m. In addition to analyses of tree morphology, tree growth and stand structure, we determined the water use of *P. euphratica* trees and stands on the basis of xylem sap flow measurements and the Penman-Monteith approach.

In accordance with the life history of the poplar stands, the tree age increases with increasing distance to the groundwater, and is accompanied by a decrease in the number of trees, tree cover, basal area, tree height, radial stem increment, crown projection area, stand density and stand transpiration, but with an increase in the diameter at stem breast height and the percentage of dead trees. The annual radial stem increment of the poplars decreased significantly with a decrease in the preceding year's water discharge of the Tarim River in the stand growing close to the groundwater, but not in those with larger distances to the water table. We conclude that under conditions of limited water resources, the supply of "ecological water" to the threatened poplar stands should not take place at the expense of the still intact ecosystems with a short distance to the water table to prevent decline of those stands.

O3 - Does seed fate determine invasion success of a highly competitive herbaceous legume in arid rangelands?

Christina Fischer[1], Johannes Kollmann[1], Thomas C. Wagner[1]

[1] Restoration Ecology, Technische Universität München, Freising, DE, christina.fischer@tum.de

Seed predation is an important ecosystem process, which significantly reduces recruitment in many plant species, thereby it can impact the invasion success of non-native but also native plants. In contrast plant invasion can be facilitated by higher seed production and more effective dispersal. Here, we studied pre- and post-dispersal seed predation, as well as primary and secondary seed dispersal of *Crotalaria podocarpa,* an invasive native herbaceous legume, which considerably increased in arid rangelands of Namibia during the past years of elevated rainfall, thereby reducing the density and vitality of economically important fodder grasses. Additionally, we quantified the impact of different predator groups on post-dispersal seed removal by experimentally excluding (i) birds, (ii) vertebrates (birds and rodents), (iii) vertebrates and large invertebrates, and (iv) neither vertebrates nor invertebrates. Seed predation was mainly caused by invertebrates, with 30% pre-dispersal seed predation in pods and up to 90% post-dispersal seed removal for free seeds on the ground which is the most persistent seed stage. The main primary dispersal mode for *C. podocarpa* is explosive dehiscence, with seeds reaching dispersal distances of up to 5 m, while wind or rolling dispersal played a minor role. Subsequent secondary dispersal by animals accounted for dispersal distances up to 19 m. Our study highlights the combined effects of pre- and post-dispersal seed predation to determine the total seed fate. However, for *C. podocarpa* invasion the remaining ca. 370 seeds m^{-2} that are constituting its persistent soil seed bank seem more decisive than the species dispersal ability. However, to reliably develop management options against economic loss through *C. podocarpa* spread seed predation, seed dispersal and seed bank dynamics have to be studied in the long-run.

O4 - Global temperate drylands will respond to climate change on average with more wet days and longer ecological droughts

Daniel R. Schlaepfer[1,2], John B. Bradford[3], Mike C. Duniway[4], Sonja A. Hall[5,6], Khishigbayar Jamiyansharav[7], Gensuo Jia[8], William K. Lauenroth[2,10], Ariuntsetseg Lkhagva[9], Seth M. Munson[3], David A. Pyke[11], Britta Tietjen[12,13], Scott D. Wilson[14]

[1]University of Basel, Section of Conservation Biology, Basel, CH, daniel.schlaepfer@unibas.ch
[2]University of Wyoming, Department of Botany, Laramie, WY, US, daniel.schlaepfer@unibas.ch
[3]US Geological Survey, Southwest Biological Science Center, Flagstaff, AZ, US
[4]US Geological Survey, Southwest Biological Science Center, Moab, UT, US
[5]Center for Sustaining Agriculture and Natural Resources, Washington State University, Wenatchee, WA, US
[6]SAH Ecologia LLC, Wenatchee, WA, US
[7]Colorado State University, Department of Forest, Rangeland and Watershed Stewardship, Fort Collins, CO, US
[8]Chinese Academy of Sciences, Institute of Atmospheric Physics, Beijing, CN
[9]National University of Mongolia, Department of Biology, School of Arts and Sciences, Ulaanbaatar, MN
[10]University of Wyoming, Program in Ecology, Laramie, WY, US
[11]U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, OR, US
[12]Freie Universität Berlin, Institute of Biology, Biodiversity and Ecological Modeling, Berlin, DE
[13]Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Berlin, DE
[14]University of Regina, Department of Biology, Regina, SK, CA

Temperate drylands cover 40% of the terrestrial surface and provide important ecosystem services. Much of our knowledge of drylands is based on meteorological dryness and on simple representations of the water cycle that do not consider interactions between soil and vegetation on soil moisture. However, ecosystem processes and thus management of drylands respond to patterns of ecological drought, which is driven by interactions among climate, weather, vegetation, and soil. Here, we present a global ecohydrological analysis of climate change impacts on patterns of soil moisture in temperate drylands and their global distribution using SOILWAT, a daily time-step, multiple soil-layer, ecosystem water balance simulation model. We simulated current conditions and responses to climate projected for the end of the century by 16 GCMs under RCP 8.5.

GCMs predict increases in growing season length and variable increases in precipitation. Our preliminary results indicate that, by the end of this century, 41% (26-74%) of the current temperate dryland area will no longer classify as temperate drylands, whereas an additional area equal to 7% (4-11%) of current extent may classify as temperate drylands. Most contractions were driven by winter months becoming too warm. Available soil water during the growing season increased for western and central Asia and northern North America, but decreased for eastern Asia, southern North America, South America and the western Mediterranean. The annual number of wet days decreased except in some parts of Asia and northern North America. Overall, the duration of growing season ecological droughts increased by 22 days (10-39 days) for deep soil layers (below 20 cm depth) and 7 days (-2-20 days) for shallow layers (above 20 cm). Consequently, future transpiration is predicted to use more water from shallower than from deeper soil layers except in some areas of central and eastern Asia.

The contractions in area of current temperate drylands suggest invasions of these ecosystems by subtropical plant and animal species such as cacti and termites. Future areas with temperate drylands may become substantially drier by the end of the 21st century, especially in deeper soil layers, with consequences for productivity, diversity, ecosystem services, and human livelihoods.

O5 - Climate change induced vegetation shifts in global temperate drylands - do they mitigate or intensify water losses from the ecosystem?

Britta Tietjen[1,2], John B. Bradford[3], Michael C. Duniway[4], Sonia A. Hall[5,6], Tamara Hochstrasser[7], Khishigbayar Jamiyansharav[8], Gensuo Jia[9], Ariuntsetseg Lkhagva[10], William K. Lauenroth[14,15], Seth M. Munson[3], David A. Pyke[11], Daniel R. Schlaepfer[12,15], Scott D. Wilson[13]

[1]Freie Universität Berlin, Institute of Biology, Biodiversity and Ecological Modeling, Berlin, DE, britta.tietjen@fu-berlin.de
[2]Berlin-Brandenburg Institute of Advanced Biodiversity Research, Berlin, DE, britta.tietjen@fu-berlin.de
[3]U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, US
[4]U.S. Geological Survey, Southwest Biological Science Center, Moab, US
[5]Center for Sustaining Agriculture and Natural Resources, Washington State University, Wenatchee, US
[6]SAH Ecologia LLC, Wenatchee, US

[7]School of Biology and Environmental Science, University College Dublin, Belfield, Dublin, IE
[8]Colorado State University, Department of Forest, Rangeland and Watershed Stewardship, Fort Collins, US
[9]Chinese Academy of Sciences, Institute of Atmospheric Physics, Beijing, CN
[10]National University of Mongolia, Ulaanbaatar, MN
[11]U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, US
[12]University of Basel, Section of Conservation Biology, Basel, CH
[13]University of Regina, Department of Biology, Regina, CA
[14]University of Wyoming, Program in Ecology, Laramie, US
[15]University of Wyoming, Department of Botany, Laramie, US

Drylands are characterized by strong coupling and feedbacks between vegetation and hydrological processes. Water availability controls the timing and amount of biomass production and, conversely, plants regulate water fluxes to the atmosphere through precipitation interception, transpiration and reduced evaporation. Climate change will likely lead to direct impacts on soil water availability and indirect impacts via changes in plant biomass and the resulting feedbacks on soil moisture. Thus, the net effect of climate change is not straightforward to predict. For example, if an increase in precipitation leads to increased plant biomass, will this result in a net increase in water availability due to enhanced inputs, or a net decrease through additional plant uptake?

In this study, we used the ecohydrological simulation model SOILWAT to assess the role of indirect, climate change induced changes in vegetation on soil water availability in global temperate drylands. We simulated current and future climate conditions projected by 16 GCMs under RCP 8.5 for the end of the century. We determined shifts in water availability due to climate change alone and due to combined changes in climate and vegetation composition and biomass. This allowed us to assess if climate induced shifts in vegetation mitigate or exacerbate the direct impacts of climate change on water availability.

Our preliminary findings suggest that vegetation changes will mostly exacerbate soil water conditions in regions that will already suffer from negative direct impacts of climate change. By contrast, in regions that will likely experience increased water availability due to the impacts of climate change alone, vegetation changes will counteract these increases due to increased water losses by interception. In only a minority of locations, climate change induced vegetation changes may lead to a net increase in water availability. These results suggest that altered vegetation structure in response to climate change may exacerbate drought conditions and may dampen the effects of increased precipitation. This underscores the value of integrated studies of dryland ecohydrology that include interactions among climatic, vegetation and edaphic conditions.

O6 - Is „good" rainfall as good as „bad" is bad? Drylands' stability towards positive and negative rainfall anomalies

Jan C. Ruppert[1], Anja Linstädter[1]

[1]Universität zu Köln, Köln, DE, jan.ruppert@uni-koeln.de

There is broad consensus that global change will increase the level of land-use and environmental stressors such as drought and grazing in drylands in the foreseeable future. These projected changes have the potential to considerably hamper primary production and the provision and functioning of ecosystem services in these regions. In a recently published study (Ruppert *et al.* 2015, Glob Change Biol), we could show that combined effects of drought and grazing may have tremendous effects on dryland stability assessed as the resistance to and recovery after a drought in aboveground net primary production. One of the main outcomes of the study was that drylands' stability is mainly related to the dominant life history of the herbaceous layer, hence, to principal strategies of resource acquisition and allocation (annual vs. perennial). Systems with an herbaceous layer dominated by annual vegetation were considerably less resistant during droughts, but showed considerable higher recovery after these have ended. However, with increasing length and severity of droughts under future climate regimes, odds are that systems dominated by annuals will gradually degrade and ultimately desertify (e.g. via seed bank depletion following recruitment failure). However, climate change will not only increase the frequency and severity of negative rainfall anomalies (i.e. droughts), but also that of positive anomalies. Still, little to none is known about drylands' responses to positive rainfall anomalies. The presented study seeks to fill this gap of knowledge and studies whether negative and positive rainfall anomalies act strictly in opposition to one another and whether there are differences in responses across the principal strategies of resource acquisition and allocation.

O7 - Convergence of aridity and grazing explains non-linear and inconsistent plant responses to grazing in dryland

Anja Linstädter[1], Jan C. Ruppert[1]

[1]University of Cologne, Botanical Institute, Range Ecology and Range Management Group, Cologne, DE, anja.linstaedter@uni-koeln.de

There is a growing need for ecological indicators that provide aggregated information for assessing states and trends. Here, it is critical to find an optimum aggregation level. Although plant functional types (PFTs) are frequently applied as indicators for the state of dryland rangelands, there is no consensus on an optimum level of functional aggregation. This hampers an upscaling from the plant community to the biome level and beyond.

With a comparative approach we searched for PFTs with aconsistent response to grazing across two areas differing in climatic aridity, situated in South Africa's grassland and savanna biomes. Hierarchical combinations of traits (related to life history, growth form and leaf width) were used to aggregate herbaceous species into PFTs. In each biome, we evaluated if PFTs responded to grazing pressure (sensitivity), and if they were little confounded by topo-edaphic conditions (specificity). We then assessed response consistency of 'good' indicators (with a sensitive and specific response) across biomes.

Instead of consistency, we found biome-specific responses and optimum aggregation levels. Some PFTs even showed an opposite response to grazing across biomes, which always manifested itself as an increase in the (more humid) grassland and a decrease in the (more arid) savanna. This non-linear response could be explained if we conceptualize it as a unimodal response along a gradient of additive forces of aridity and grazing. Along this gradient of 'environmental harshness', grassland plots under low grazing pressure will occupy the side of most favourable environmental conditions captured in this study, and savanna plots under high grazing pressure the most unfavourable ones.

We conclude that the striking lack of generalizable PFT responses to grazing is due to a convergence of aridity and grazing effects, and unlikely to be overcome by more refined classification approaches.

O8 - The DroughtAct experiment: Exploring ecosystem functioning and management options in the face of drought

Edwin I. Mudongo[1], Jan C. Ruppert[1], Anja Linstädter[1]

[1]Range Ecology and Range Management Group Botanical Institute, University of Cologne, Cologne, DE

Livestock farming is the dominant land use practice in southern African drylands. Global change scenarios project increasing livestock numbers as well as more frequent and severe droughts, which have the potential to negatively impact ecosystem functioning and ecosystem service (ES) supply in this region. Here we introduce DroughtAct, an experimental approach to investigate functional responses of grazed ecosystems to severe drought, and to explore management options in face of these extreme events. DroughtAct, which is part of the Limpopo Living Landscapes project (LLL), is located in a semi-arid thornbush savanna of South Africa's Limpopo province. Eight treatments compare realistic scenarios of rangeland management in face of centennial droughts varying in length. Assessment of ES provision and multiple ecosystem responses commenced with the 2014/15 growing season and will continue for a minimum of two more seasons. Sampling includes plant population dynamics, soil functioning, as well as intra- and interspecific variation in plant functional traits. Preliminary results show a decreased functionality and ES provision under drought and continued grazing, and suggest that grazing management may mitigate drought effects. We expect an improved understanding of the interactive effects of drought and grazing on semi-arid ecosystems of Southern Africa. We also aim to identify suitable adaptation or intervention strategies to mitigate climate change effects in semi-arid rangelands.

Key words: Climate change, ecosystem service, grazing management, semi-arid

P1 - Distributional patterns of local ecological knowledge on forage plants: Insights from local agro-pastoralists in West Africa

John-Baptist S. N. Naah[1], Irit Eguavoen[2], Reginald T. Guuroh[2], Anja Linstädter[1]

[1]University of Cologne, Cologne, DE, jnaahngm@smail.uni-koeln.de
[2]University of Bonn, Bonn, DE

Although a plethora of ethnobotanical studies have focused on distribution of local ecological knowledge (LEK) among its holders, fewer studies have looked into detail whether it is ethnicity or climatic aridity which is more important in explaining the body of LEK on forage plants. In this study, we have also assessed how age and gender may influence LEK distributional patterns. We employed freelisting - whereby local agro-pastoralists (N = 450) randomly selected in 15 villages were simply asked to list as many as possible forage plants eaten by cattle, goats and sheep. Generalized linear mixed-effect models (GLMM) and model selection procedures were performed. We hypothesize that:

1. People in arid locations have higher LEK of forage plants than in humid areas.

2. Men have higher LEK of forage plants than women.

3. Older adults are more knowledgeable in forage plants than young adults.

The freelisting approach generated about 200 species corresponding to 155 genera and 53 families. We found evidence that while aridity-based model had a stronger predictive power of LEK depth and richness in overall forage plants (marginal, R_m^2 = 27%, conditional, R_c^2 = 35%) and crop-related forage (R_m^2 = 25%, R_c^2 = 26%), ethnicity-based model was also better in explaining variance in LEK richness in herbaceous (R_m^2 = 18%, R_c^2 = 30%) and woody forage species (R_m^2 = 17%, R_c^2 = 27%). Effects of single variables and their interacting effects were tested and discussed. The diversified composition of herbaceous, woody vegetation and crop species in freelisted items underscores the usefulness of an integrated feeding approach adopted by local farmers especially in periods of droughts.

P2 - Sustainable Management of Rangelands - Integrating Practitioner‘s Knowledge

Jenny Bischofberger[1], Katharina Brüser[1], Oliver Schulz[1], Stefan Liehr[1]

[1]ISOE- Institute for Social-Ecological Research, Frankfurt/Main, DE, bischofberger@isoe.de

Arid and semi-arid rangelands provide a living for more than 370 million people worldwide and about 80 per cent of the nutrition for livestock. Resource degradation, fostered by climate change and maladapted land use, has become a serious challenge in such rangelands, negatively impacting ecosystem function, livestock production and the livelihoods of the people. In Namibia, the driest country of sub-saharian Africa, 45 per cent of the national land area can only be used as rangeland and the livelihoods of a majority of Namibians directly or indirectly depend onnatural rangelandvegetation and related water resources.

Thus, to prevent further degradation of natural resources the implementation of adapted sustainable management techniques becomes vital. However, these ecosystems are very complex with regard to the close interactions between vegetation dynamics, soil moisture, groundwater recharge, and soil erosion, posing challenges for good management choices. Furthermore, altered management options may be impeded by social or economicincentives, believes and preferences.

Within the interdisciplinary Optimass project, we focus on management options of commercial livestock farmers in Namibia. Their opportunities for action were identified and the impact on the ecosystem and the societal utilisation interests analyzed. We aim to better understand the link between actors and rangeland ecosystems by applying "participatory modelling" techniques, integrating local knowledge. Conducting qualitative interviews with farmers and other experts, their practical knowledge will be combined with scientific knowledge from a process-based eco-hydrlogical model. Whilem process based models can improve the understanding of the complex links between water and soil, assessments with resource users elucidate drivers for management.

We will present first results on management options, challenges and impacts in Namibian rangelands. Our final aim is to derive recommendations for policy and practice while new possiblities of knowledge exchange will be created within the process.

P3 - Studying buffer mechanisms in the Eneabba Sandplain shrublands, a Mediterranean-type ecosystem in South-Western Australia

Hanna Weise[1], Neal J. Enright[2], Joseph B. Fontaine[2], Raymond H. Froend[3], Britta Tietjen[1]

[1]Freie Universität Berlin, Institut für Biologie, Berlin, DE, hanna.weise@fu-berlin.de
[2]Murdoch University, School of Veterinary and Life Sciences, Perth, AU
[3]Edith Cowan University, School of Natural Sciences, Joondalup, AU

Mediterranean-type ecosystems (MTEs) are particularly vulnerable to climate change because the climate in these regions is projected to become hotter and drier. MTEs also feature various buffer mechanisms which facilitate persistence through and or recovery from disturbances like droughts and fires. Will these buffer mechanisms be affected by climate change in a way that adversely impacts their functionality?

Our study MTE, the species-rich Eneabba Sandplain shrublands, South-Western Australia is characterized by a quartzite sand dune system. The dunes overlie a clay hardpan and a lateritic gravel layer which is resistant to penetration by water and roots. Plant water availability is largely limited by the depth of soil above it. Therefore higher dune areas represent patches with more water-availability throughout the year than lower dunes and swales. This soil water storage constitutes a potential local buffer mechanism which allows plants to persist through prolonged periods with low water availability. A decrease in rainfall and constant higher temperatures may lead to a decrease in functioning of this buffer mechanism and consequent loss of species and vulnerable functional traits.

A further buffer mechanism are seed banks. Climate manipulation experiments in the Eneabba Sandplain have shown that the effects of a reduced water availability include diminished seed production and reduced seedling establishment.

In our poster contribution we present a new modeling framework to study these buffer mechanisms. It integrates the ecohydrological model EcoHyD and an existent grid-based vegetation model. Our approach allows us to study climate-effects on the different buffer mechanisms as well as their interplay, e.g. the feedback between water availability and seed production. We demonstrate the model`s potential to study the relevance of individual buffer mechanisms to community structure and composition (measured as composition of PFTs).

The buffer mechanisms represent different aspects of the resilience of the vegetation community of the Eneabba Sandplain (i.e. persistence, recovery). Our long term goal is to operationalize resilience for this particular ecosystem and to generalize the findings for other MTEs.

P4 - Long-term effects of wood harvest on Populus euphratica in riparian forests at the Tarim River, NW China

Petra Lang[1], Michael Jeschke[1], Tobias Wommelsdorf[1], Tobias Backes[1], Chaoyan Lv[2], Ximing Zhang[3], Frank M. Thomas[1]

[1]University of Trier - Faculty VI - Geobotany, Trier, DE, langp@uni-trier.de
[2]Xinjiang Cele National Field Scientific Observation and Research Station of Desertification and Grassland Ecosystem, Cele, CN
[3]Chinese Academy of Sciences, Xinjiang Institute of Ecology and Geography, Urumqi, CN

Along rivers in arid regions of Central Asia, Euphrates poplar (*Populus euphratica* Oliv.) is the dominant tree species of the riparian ('tugai') forest. To the rapidly growing population in the Tarim Basin (Xinjiang, NW China), these forests provide important provisioning and regulating ecosystem services. From the trade-off between the demand of the human population for resources and the necessity to conserve the forests, the question arises whether a sustainable use of the poplars through pollarding, a traditional way of using tree biomass, is possible.

*P. euphratica*trees and stands representative of different intensities of use (no, moderate and intense pollarding) were investigated with regard to stand structure, tree morphology and radial stem increment. For comparing the performance of the trees under and their recovery from a stress event, we additionally calculated an index of resilience (ratio of basal area increment before and after a pollarding event) and determined crown efficiency and intrinsic water use efficieny (iWUE). Our study was conducted at the upper reaches of the Tarim River within the framework of the joint German-Chinese project SuMaRiO (Sustainable Management of River Oases along the Tarim River).

Our study confirms that even a moderate extent of pollarding leads to a significant reduction in tree height and basal area increment and significantly increases the occurrence of stem hollowness. Although *P. euphratica* showed a negative response to pollarding, it is able to compensate for the removal of above-ground biomass to a certain extent: the intensely pollarded trees displayed a higher production of secondary stems and a lower iWUE compared to the non-pollarded trees as well as an index of resilience close to 1.

We conclude that a sustainable use of *P. euphratica* is possible under moderate forms of pollarding. Furthermore, we found a significant relationship between basal area increment on the one hand, and crown area and crown volume, on the other, which is promising for developing strategies to predict biomass production by using remote sensing data.

P5 - Impact of Forest Disturbance on the Structure and Species Composition of a Tropical Dry Forest in South Ecuador

Ruffy Rodrigo[1], Philipp Butz[1], Jürgen Homeier[2], Eduardo Cueva[3], Sophie Graefe[1]

[1]Tropical Silviculture and Forest Ecology, Georg-August-Universität, Göttingen, DE, RODRIGORUFFY@GMAIL.COM
[2]Plant Ecology and Ecosystem Research, Georg-August-Universität, Göttingen, DE
[3]Naturaleza y Cultura Internacional, Loja, EC

Tropical dry forests are unique and biodiversity rich ecosystems, but are highly threatened due to the expansion of human settlements and agricultural activities, resulting in a fragmented forest landscape. Also climate change poses a risk to tropical dry forest, which may deteriorate its capacity to act as a carbon sink and provider of ecosystem services at the landscape scale. Restoration activities have been put into action to respond to those issues. However, most forest inventories were conducted in wet tropical forests and less attention has been given to tropical dry forests so far. The present study was conducted in a dry forest region of Southern Ecuador, that is characterized through low annual rainfall and a long dry season of eight months. Due to the mountainous topography the area covers altitudes of 500 to 1200 m asl. Forest areas adjacent to villages are commonly used for grazing cattle. To this end the study aimed to analyze the impact of forest disturbance on the composition of tree species, as well as to estimate their aboveground biomass (AGB). This will be then compared to a previously conducted inventory of an adjacent undisturbed forest. A systematic grid sampling was applied using the open software Quantum GIS. A total of 50 plots with a sampling plot size of 531m^2 were established along an altitudinal gradient. In every plot, tree species, DBH and tree height were recorded. In addition, wood density of the most common species was determined. The results of this study show how disturbance influences the structure and tree diversity of a tropical dry forest ecosystem. Knowledge on determining species composition by means of inventories are necessary for decision making processes regarding a sustainable management and conservation of threatened ecosystems such as tropical dry forests.

P6 - Short-term structural responses of woody savanna vegetation to non-selective chemical bush control, South Africa

Sampie van Rooyen[1], Klaus Kellner[1], Niels Dreber[1,2]

[1]North-West University, Unit for Environmental Sciences and Development, Potchefstroom, ZA

[2]University of Göttingen, Department of Ecosystem Modelling, Göttingen, DE, ndreber@uni-goettingen.de

A high proportion of South Africa's semi-arid Molopo Bushveld is thickened by indigenous increaser shrubs and trees as a result of ill-adapted grazing management and suppression of fires. A common approach to restore a balanced and productive woody:grass ratio in this savanna is the use of systemic, soil-applied arboricides. If larger areas need to be treated, the arboricide is applied by aircraft, non-selectively killing all sensitive woody species. This creates a highly dynamic, competitive environment among the vegetation components, and knowledge about resultant vegetation development is decisive for appropriate management responses. In this case study, the woody layer in thickened and 6-year old controlled rangelands was comparatively assessed. The objective was to describe structural changes and demographic response patterns of selected key woody species.

The short-term effect of the chemical control was a significant reduction of woody density (58%) and phytomass (72%). This also had implications for the composition, which showed a significant dissimilarity to thickened sites. Species contributing most to the dissimilarity were *Senegalia mellifera*, *Vachellia luederitzii* and *Grewia flava*. The chemical treatment effectively thinned out small to medium-sized woody individuals, but seedlings and saplings (woodies ≤0.5 m) of mainly *S. mellifera* re-infested to densities similar to the initial condition. The mean height of the recruitment layer was about 40 cm, suggesting a favorable event for germination and establishment shortly after chemical control. Moreover, the arboricide must have been either leached out into deeper soil layers or quickly metabolized.

Results demonstrate a threat of savanna re-thickening following non-selective bush control, which must be attributed to initially low grass densities and extensive loss of larger woodies, and an accordingly concomitant change in inter- and intra-life form competition. This counteracts a progressive development of vegetation towards a stable and productive grassy state. Vegetation retrogression can only be avoided by a selective follow-up and maintenance control of woody recruits, in particular *S. mellifera*, within the first years after arboricide application.

P7 - Predicting savanna dynamics in response to management and climate change: a modelling approach for decision support

Bastian Hess[1], Sebastian Hanss[1], Kerstin Wiegand[1], Klaus Kellner[2], Theunis Morgenthal[3], Andre F. van Rooyen[4], Franci Jordaan[5]

[1]Department of Ecosystem Modelling, University of Göttingen, Göttingen, DE, Bastian.Hess@forst.uni-goettingen.de
[2]School of Biological Sciences, North-West University, Potchefstroom, ZA
[3]Department of Agriculture, Forestry and Fisheries, Pretoria, ZA
[4]International Crops Reserch Institute for the Semi-Arid Tropics, Bulawayo, ZW
[5]Department of Agriculture, Conservation and Environment, North-West Province, ZA

Bush encroachment is one of the forms of land degradation in South Africa. The dramatic increase of woody species which suppress grass growth has serious ecological and economic consequences such as reduced carrying capacity for domestic livestock and game. However, the driving forces behind these dynamics remain still mainly unknown.

Our ultimate goal is to develop a simulation model that will be able to simulate complex spatio-temporal cross-scale events to investigate savanna-vegetation dynamics and the patterns of bush encroachment and control to make predictions and appropriate decisions for optimal management strategies. The development of the model is part of the IDESSA-project aiming at implementing an integrative decision support system for sustainable rangeland management in southern African savannas.

As a first step, we have developed a prototype for the semi-arid Molopo region but the final model will have the flexibility to represent savannas along a gradient from arid to humid regions in South Africa. Optimization of model complexity is guided by a sensitivity analysis. This way, crucial processes and parameters that need further enhancements were separated from processes that may be simplified.

The simulation model is grid-based with cell sizes of 30 m x 30 m representing dominant grass and woody vegetation types. The temporal rules are based on daily (e.g. precipitation and soil moisture), monthly (e.g. temporal vegetation transition and growth) and annual (e.g. spatial vegetation transition and seed dispersal) time steps which act on different spatial scales (i.e. patch, multi-patch, landscape). This allows us to model the spatio-temporal dynamics of the vegetation responding to the different impacts of climatic conditions (temperature and precipitation), soil moisture, management (type of animals, stocking rate, type of grazing/browsing system, arboricide application and fire), as well as demographic and phenological aspects (biomass production, seed dispersal, germination and mortality) of dominant plant types (unpalatable and palatable perennial grasses, annual grasses and woody plants).

Here, we will present the prototype model for the semi-arid Molopo region for different landscape scenarios as well as the results of the sensitivity analysis.

P8 - Trait-based process modelling of ecohydrological feedbacks in arid and semi-arid savannas

Gregor Ratzmann[1], Britta Tietjen[1], Dirk Lohmann[2], Tobias Kümmerle[3]

[1]Freie Universität Berlin, Berlin, DE, gregor.ratzmann@fu-berlin.de
[2]University of Potsdam, Potsdam, DE
[3]Humboldt-Universität zu Berlin, Berlin, DE

Understanding of plant-water interactions in drylands is crucial to anticipate potential impacts of future land use and climatic changes on a landscape scale. Particularly, the coupling of plant growth, atmospheric processes and soil water through the process of carbon (C) fixation represents a key ecohydrological feedback loop in arid and semi-arid environments. This work presents an extension of the existing spatially explicit ecohydrological savanna model EcoHyD by simple mechanistic trait-based processes. Plant growth is enabled through C fixation during photosynthesis. C assimilation interacts with respiration and is directly coupled to the atmosphere and the water cycle as well as atmospheric CO_2 through stomatal conductance. Assimilated carbon is partly respired and the residual is subsequently allocated to different carbon pools: leaf C and root C (herbaceous and woody plants) and additionally wood C for woody growth forms. This allocation thus describes the process of plant growth. Model parameters are chosen in a way to facilitate their estimation. This is achieved through parameter definitions closely resembling easily measured plant traits. Here, preliminary results of plant growth and response to environmental factors in arid and semi-arid savannas are presented and viewed in the light of a sensitivity analysis. This sensitivity analysis may help identifying key plant traits and their potential connection to survival strategies in different arid and semi-arid environments. This study thus is a first step towards an analytical prediction of future impacts of climate change and land use on dryland ecosystems. It moreover will contribute to our present understanding of processes and mechanisms driving changes in plant communities and ecosystem services such as forage production. The presented work is part of the SPACES project OPTIMASS (funded by the German Federal Ministry of Education and Research) and particularly focuses on Namibian savanna rangelands.

P9 - The role of perennial grass roots in vegetation responses to land use and climate in a simulated semi-arid African savanna

Elise Münch[1], Dirk Lohmann[1], Florian Jeltsch[1]

[1]University of Potsdam, Plant Ecology and Nature Conservation (OPTIMASS-Project), Potsdam, DE, elise.muench@uni-potsdam.de

In semi-arid African savannas shrub encroachment is a threatening form of land degradation. Carrying capacities and the economic output of rangelands are diminished by this increase of woody for cattle unpalatable shrubs. As land use is also considered to be one of the main promoters of this phenomenon it is crucial for farmers to manage their rangelands sustainably.

The causes of livestock induced shrub encroachment are mainly related to the selective removal of perennial grass biomass by cattle. This in turn leads (1) to a reduced probability of fires, which are able to regulate shrub establishment and (2) to a reduced competitive ability of the grasses. Regarding the latter belowground biomass dynamics seem to play an important role. Such biomass reserves can for example buffer shoot removal events like grazing, fire or drought as green biomass can resprout from belowground resources. However, although their importance for the resilience of semi-arid savanna rangelands is potentially very significant, little research has been conducted in this field until now.

The aim of this modeling study is to clarify the ecological role of belowground reserves in vegetation responses to grazing. We included perennial grass root biomass along with intra-annually highly dynamic processes into an existing ecohydrological model for semi-arid African savannas (EcoHyD). Resulting implications for livestock management will be discussed.

P10 - Phylogeography of the Oophytum Complex on Quartz Field Islands of the Southern African Knersvlakte

Barbara Rudolph[1], Frederic Carstens[1], Rika Spamer[1], Anna-Lena Rau[1], Ute Schmiedel[1]

[1]Biodiversity, Evolution and Ecology, Biocenter Klein Flottbek, Hamburg, DE, F.Carstens@gmx.net

The leaf succulent genus *Oophytum* (N.E.Br.)is endemic to small quartz field islands that are dispersed in shale-derived soilsof the Knersvlakte, a centre of diversity and endemism in the arid Succulent Karoo of South Africa. *Oophytum*is a member of the plant family Aizoaceae, and therein of the most species-rich subfamily Ruschioideae. It isdescribed to be divided into the two species *O.nanum* and *O.oviforme*. A third species, *O. nordenstamii*, was discussed due to differing flowering colour but later sunken into *O. oviforme*. The two remaining species differ slightly in shape and sizes of their leaves, fruits and seeds. They grow under different microhabitat conditions and differ in flowering time. While *O. nanum* is located in the north and east of the Knersvlakte, *O. oviforme* (incl.*O. nordenstamii*) grows in the south-western part. Both species co-occur in close neighbourhood in the centre of the genus' distribution area.

The relationship of this small *Oophytum* complex was investigated with a combined molecular and soil analysis. A total of 23 populations 14 populations of *O. nanum* and nine of *O. oviforme*each with ten individuals per population were sampled in the field. The soil texture and chemistry ofeach sampled quartz field population were analysed. Using AFLPdata, cluster and PCO analyses were calculated, and a phylogenetic tree based on *mat*K and *trn*G-*trn*S sequence data was computed.

As almost all individuals could be assigned to their populations in the neighbour joining analysis a restricted gene flow between the island populations could be identified. The PCO and phylogenetic analyses indicate at least two different gene-pools that do not correspond to the species concept that was based on morphological data. Instead, athe genepools mainly relate to the geographical patterns of drainage basins of ephemeral rivers and some soil features such as density of stone coverage and steepness of slopes.

END OF SESSION 8

Session 9 - Illuminating the black box: causes, consequences, and capture of interactions in soil

Short title: Illuminating the black box

CHAIRS: PROF. DR. NICO EISENHAUER, DR. FRIDERIKE BEYER, DR. SIMONE CESARZ

O1 - Inhibitory potential of naphthoquinones leached from leaves and exuded from roots of the invasive plant Impatiens glandulifera

Hans-Peter Rusterholz[1], Gaetan Glauser[2], Regina Ruckli[1], Bruno Baur[1]

[1]Section of Conservation Biology, Department of Environmental Sciences, University of Basel, Basel, CH
[2]Chemical Analytical Service of the Swiss Plant Science Web, Institute of Biology, University of Neuchâtel, Neuchâtel, CH

Invasive plants have the potential to modify the abundance and composition of soil microorganisms and to disrupt symbiotic association between soil fungi and host plants. Exploring the effects of allelopathic plant chemicals on the growth of native vegetation is therefore essential to understand their ecological roles and importance in exotic plant invasion. Naphthoquinones have been identified as potential growth inhibitors produced by *Impatiens glandulifera,* an exotic annual plant which recently invaded temperate forests in Europe. However, the way naphthoquinones are released by *I. glandulifera* and their inhibitory potential have not yet been examined. We quantified the naphthoquinone content in cotyledons, leaves, stems and roots from plants of different age of both the invasive *I. glandulifera* and native *Impatiens noli-tangere* as well as in soil extracts and rainwater rinsed from leaves of either plant species using ultra-high pressure liquid chromatography-mass spectrometry (UHPLC-MS). We identified the compound 2-methoxy-1,4-naphthoquinone (2-MNQ) exclusively in plant organs of *I. glandulifera*, in resin bags buried into the soil of patches invaded by *I. glandulifera* andin rainwater rinsed from its leaves. This indicates that 2-MNQ is released from the roots of *I. glandulifera* and leached from its leaves by rain. Bioassays using aqueous shoot and root extracts revealed a strong inhibitory effect on the mycelium growth of three ectomycorrhiza fungi. In a field experiment, the observed reduction in both EM colonization and EM morphotype richness on roots of beech saplings is mainly caused by the high amount of naphthoquinones measured in plots with the invasive plant. These findings indicate that the release of 2-MNQ contribute to the invasion success of *I. glandulifera* and thus support the novel weapon hypothesis.

O2 - Mesofauna exclusion accelarates decomposition of secondary metabolites in leaf litter

Christian Ristok[1,2], Katrin Seidelmann[3], Michael Scherer-Lorenzen[3], Pascal A. Niklaus[4], Helge Bruelheide[1,2]

[1]Martin-Luther University Halle-Wittenberg/ Institute of Biology/ Geobotany and Botanical Garden, Halle / Saale, DE, christian.ristok@idiv.de
[2]German Center for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE, christian.ristok@idiv.de
[3]University of Freiburg, Faculty of Biology/ Geobotany, Freiburg, DE
[4]University of Zurich, Institue of Evolutionary Biology and Environmental Studies, Zurich, CH

Plant polyphenols are important secondary metabolites known to affect microbial and mesofauna communities that might influence various ecological processes, among them leaf litter decomposition. Comparative cross-species studies of plant species differing in polyphenol contents are rare. In particular, little is known about the fate of plant polyphenols during leaf litter decomposition, and the effect of mesofauna on polyphenol decomposition rates.

We hypothesized that phenolics and tannin decomposition rates (1) differ between different species, and (2) decrease with mesofauna exclusion. In addition, we tested whether whole leaf litter decomposition and polyphenol decomposition can be predicted from litter quality traits.

We performed a litter decomposition experiment in the context of the BEF-China project (www.bef-china.de). Leaf litter of seven Chinese tree species was exposed to field decomposition conditions and aggregated in different mixtures of different species richness (1, 2 and 4 species). Mesofauna were excluded with fine mesh (mesh size 0.25 mm). Total phenolics were determined using the Prussian Blue Assay. Tannin content was assessed using a modified version of the Radial Diffusion Assay. We calculated decomposition rates for both secondary metabolite groups.

We found that decreases in total phenolics and tannin content were highly species-specific, yet were not influenced by litter diversity. Mesofauna exclusion increased phenolics decomposition across all species, but differed in its effect on tannin decomposition across species. This may be due to structural changes of the litter during decomposition and the destruction of fungal hyphae connections by the mesofauna. For all species, leaf toughness and leaf nitrogen content showed contrasting patterns of variation with polyphenol decomposition. The absolute amount of polyphenols decreased by a factor of 8 faster than total leaf mass.

The results of our study provide insight to the fate and role of polyphenols during leaf litter decomposition, as well as the importance of mesofauna in modulating this process. However, it remains a challenge to identify the specific function of polyphenols during litter decomposition.

O3 - Similar, but not identical - Significance of intraspecific variation for decomposition processes

Hanno Müller[1,2], Martin Zimmer[1]

[1]Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, DE, hanno.mueller@uni-bremen.de
[2]University of Bremen, Bremen, DE, hanno.mueller@uni-bremen.de

Over the last century, ecosystems have undergone dramatic changes, accompanied by declines and changes in biodiversity at all levels, from biotopes to species and genetic variation within species. Considerable effort has been invested in ecological research to understand the functional importance of biodiversity as a regulator of ecosystem processes. However, intraspecific phenotypic variation has been considered rarely in this context. Regarding intraspecific variation, many studies only focus on genetic variances or anatomical parameters, but scarcely on physiological factors and their ecological consequences.

Consequently, during this project we want to examine how intraspecific variation affects ecosystem processes. More specifically, how intraspecific variation of an isopod species affects decomposition processes. Many studies have shown that decomposition processes are influenced by environmental conditions and chemical litter composition, but also by richness and identity of detritus feeders. So far, however, detritivore intraspecific variation in consumption and digestion of dead organic material has been neglected – although this intraspecific variation, as inter-specific diversity, is likely to undergo considerable changes in the future.

Results from a feeding experiment including different levels of intraspecific feeder diversity and interspecific and intraspecific food diversity as well as measurements of digestive phenotype variation are presented.

O4 - Contributions of root-assoicated fungi to plant community composition and forest productivity

Yu Liang[1], Naili Zhang[1], Keping MA[1]

[1]Institute of Botany, CAS, Beijing, CN, coolrain@ibcas.ac.cn

As an essential component of terrestrial ecosystem, fungi are considered as an important factor in determining plant diversity and productivity. In the present study,828 root samples were taken from a 24 ha plot in a subtropical forest of China. Root-associated fungal diversity was determined using Illumina Miseq and contributions of fungal diversity to plant community composition and plant productivity were evaluated using variation partitioning and pathway analysis. The results of showed that, (1) variations in plant composition can be explained by fungal community and space; (2) space-independent fungal effects decrease with distance while space-dependent fungal effects and fungi-independent spatial effects increase with distance; (3) forest productivity may be affected by both species composition of plant and EMF community.

O5 – Unravelling mechanisms linking plant community composition and soil disease suppression

Ellen Latz[1,2], Nico Eisenhauer[1,4], Björn C. Rall[1,2], Stefan Scheu[3], Alexandre Jousset[5]

[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE, ellen.latz@idiv.de
[2]University of Jena, Jena, DE, ellen.latz@idiv.de
[3]Georg-August University of Göttingen, Göttingen, DE
[4]University of Leipzig, Leipzig, DE
[5]University of Utrecht, Utrecht, NL

Soil-borne plant diseases cause dramatic yield losses, and adverse impacts of chemical pesticides on the environment and human health foster the need for alternative disease control. Pathogen antagonistic microbes primarily drive natural disease suppression in soil. Accordingly, research so far mostly focused on microbial agents, but plant disease suppression is most likely dependent on a complex set of rhizosphere properties.

Via measuring plant influences on several biotic as well as abiotic soil properties and analysing their direct as well as indirect influence on soil disease suppressive ability in a structural equation model, we were able to reveal that pathogen suppressiveness is indeed interactively shaped by a complex set of factors which are essentially driven by previous plant community composition. Our results indicate that among an important indirect role of plant communities in shaping soil-disease suppression (e.g. via changes in root biomass, soil pH and the abundance of important biocontrol groups), plants interactively directly affect the soils suppressive potential.

This study represents an important first step in understanding the complexity of mechanisms linking plant community composition and disease suppression. We propose that an interactive synergy of direct as well as indirect effects of plants therefore have to be taken into account in order to predict and manipulate plant-disease suppression.

O6 - Incorporation of 13C and 15N derived from beech and ash litter into soil mites

Sarah Zieger[1], Verena Eissfeller[1], Mark Maraun[1], Stefan Scheu[1]

[1]University of Göttingen, Göttingen, DE, szieger@gwdg.de

It has been suggested that forest soil food webs predominantly rely on root rather than leaf litter derived carbon, but it is also well documented that detritivorous soil invertebrates process large quantities of leaf litter material. Focusing on decomposer (Oribatida) and predatory mites (Mesostigmata) we investigated the incorporation of resources from leaf litter rich (European beech, *Fagus sylvatica*) and poor (European ash, *Fraxinus excelsior*) in structural compounds into soil microathropods using stable isotope methodology. Further, using litter mixtures we investigated if soil mites preferentially incorporate carbon and nitrogen derived from beech or ash litter. In addition, we identified the impact of mycorrhizal fungi on soil mite nutrition using the rotated core method.

Primary decomposer soil microathropods incorporated most litter C and N, but the contribution to body tissue element concentration was low suggesting that they predominantly rely on other resources than litter from the previous year. Generally, soil mites incorporated more C and N from ash than from beech litter. In contrast to our expectations the use of litter resources by soil mites was little affected by mycorrhiza.

The results underline that, at least during the first year of litter decay, leaf litter resources are of minor importance for soil animal nutrition, and this is particularly true for litter rich in structural compounds such as beech.

O7 - Molecular gut content analyses of nematode prey in soil microarthropods of forest soil food webs

Kerstin Heidemann[1], Mark Maraun[1], Liliane Ruess[2], Stefan Scheu[1]

[1]Georg August University, Göttingen, DE, kheidem@gwdg.de
[2]Humboldt University Berlin, Berlin, DE

Trophic interactions of soil organisms are difficult to investigate in the field. Due to the opaqueness of soil, predator - prey interactions their functions are little known. Especially the role of nematodes as prey in soil food webs is understudied. Nematodes likely form part of a multitude of predator - prey interactions as they reach high densities in virtually any soil, are small and soft bodied. However, they are difficult to detect as prey organisms, e.g. by microscopic gut content analysis. Therefore, little is known on the nematode-based food chain.

Microarthropods also reach high densities in soil and recent studies indicated that a number of microarthropod taxa previously assumed to live as detritivores feed on nematodes. However, their diet and trophic niche is still little known as many microarthropod species ingest only prey fluids. Therefore, molecular approaches are needed to uncover trophic links in soil microarthropod food webs.

Molecular gut content analysis uses molecular markers, i.e. primers for certain prey taxa, to detect prey DNA in the gut of predators.We developed primers for investigating the role of free-living bacterial feeding nematodes as prey for soil microarthropods, i.e. collembolans and mites. Bacterial feeding nematodes are among the most important bacterial grazers. Thereby, they hold a key position in the bacterial energy channel in soil which is assumed to quickly transfer carbon from low to high trophic levels. Further, we used the established molecular approach to assign mechanisms influencing nematode - predator interactions in forest soil systems, including scavenging, habitat structure, forest type, prey density and prey defense. We found that all those mechanisms are affecting nematode-predator interactions.

O8 - Compound-specific amino acid analyses (13C and 15N) as a novel tool to investigate trophic interactions in soil

Melanie Maraun (nee Pollierer)[1], Thomas Larsen[2]

[1]J.F. Blumenbach Institute of Zoology and Anthropology, Georg-August-University, Göttingen, DE, mpollie@gwdg.de
[2]Leibniz-Laboratory for Radiometric Dating and Stable Isotope Research, Kiel, DE

Soil animal food webs are complex and heterogeneous systems. Despite their fundamental role for ecosystem functioning, basic processes therein are not well understood. To disentangle the role of different basal resources such as bacteria, fungi and plants, and to assign trophic positions of soil animals within the food web, indirect methods, such as stable isotope analyses, molecular gut content analyses, or fatty acid analyses have to be applied.

The compound-specific analysis of amino acids (AAs) has made substantial progress in marine systems in delineating isotopic baselines for trophic level estimation, and in distinguishing between different resources used by consumers. Very recently, it has also been used for terrestrial food webs to a) distinguish between plant, fungal, and bacterial derived inputs by utilizing differential patterns of 13C in essential AAs, and to b) give precise estimates of trophic position within the food web using compound-specific 15N signatures.

Here, I present a first attempt to utilize dual compound-specific AA measurements for soil animal food webs. I conducted a laboratory experiment in which I fed different basal resources (fungi, bacteria, tree leaves) to springtails (collembola). The springtails in turn were fed to centipedes and spiders. By analysing 13C signatures of essential AAs in resources and animals, I was able to assign first and second order consumers to their respective resources. Using 15N signatures of trophic and source AAs, I constructed trophic isoclines that can delineate exact trophic positions and compartments within the food web.

In a field study, we measured 13C signatures of essential AAs in endogeic and anecic earthworms to estimate the proportion of plant, fungal, and bacterial derived resources and found large contributions of bacterial AAs, especially to the diet of endogeic worms, possibly originating in part from symbiotic gut microorganisms.
Compound-specific AA analyses thus represent a promising new tool to shed light into the black box of soil animal food webs.

O9 - Magnetic Resonance Imaging of roots growing in dynamic soil environments

Robert Koller[1], Dagmar van Dusschoten[1], Johannes A Postma[1], Daniel Pflugfelder[1], Siegfried Jahnke[1]

[1]Institute of Bio- and Geosciences: Plant Sciences (IBG 2), Forschungszentrum Jülich GmbH, Jülich, DE, r.koller@fz-juelich.de

Root system development is essential for the plant's water and nutrient supply and thereby critical to its performance and yield in a dynamic environment. The opaque nature of soil however prevents direct observation of belowground processes. While imaging root development in rhizotrons has been informative in many studies, rhizotrons only make an indeterminable fraction of roots visible at an obstructive window. Therefore non-invasive monitoring of the 3D root architecture has high potential for gaining new insights into root growth dynamics and functioning. Magnetic resonance imaging is such a method, and we adapted our protocols, greatly improving the detection of fine roots. We were able to non-invasively visualize and quantify root traits of the model species Arabidopsis and Brachypodium as well as crop species Maize and Barley. Wewill show how the abiotic environment influences root development over time, demonstrating the importance of understanding system dynamics for interpreting the value of different traits for nutrient acquisition and growth.

O10 - Plant diversity maintains high levels of soil food web complexity during extreme weather events

Simone Cesarz[1,2], Marcel Ciobanu[4], Daniela Wagner[3], Nico Eisenhauer[1,2]

[1]iDiv - German Centre for Integrative Biodiversity Research, Leipzig, DE, simone.cesarz@idiv.de
[2]University of Leipzig, Leipzig, DE, simone.cesarz@idiv.de
[3]Friedrich Schiller University of Jena, Jena, DE
[4]Institute of Biological Research, Branch of the National Institute of Research and Development for Biological Sciences, Cluj-Napoca, RO

One impactful consequence of global change is increased frequency of extreme weather events, such as floods and summer droughts. Plant diversity can maintain ecosystem functioning, in terms of primary productivity, despite multiple co-occurring climate change effects. However, although soils harbor a plethora of essential ecosystem functions, it is largely unexplored if also belowground processes can be buffered by plant diversity against environmental perturbations. Here we investigated the interactive effects of plant diversity, a natural flood, and a subsequent summer drought on soil microbial and nematode communities in a field experiment to investigate responses of soil food web structure and functional indices.

We found no significant interactions between plant diversity, flooding intensity, and drought. While effects of the summer drought were negligible, flooding inten-

sity reduced nematode diversity and functional indices indicating simplified food web structure. Further, soil community composition shifted in response to the flood with r-strategists being favored over K-strategists, and fungi and gram-positive bacteria being favored over gram-negative bacteria. Although the response of some individual taxa, such as plant-feeding nematodes, depended on the interaction of plant diversity and flooding intensity, positive plant diversity effects on soil microbial biomass and soil food web complexity were found at all levels of flooding intensity for nematodes indicating soil food web complexity. These results indicate that plant diversity can maintain high levels of soil food web complexity during extreme weather events.

O11 - Making the bad worse: Drier environment intensify detrimental effects of climate warming on decomposer activity

Madhav Thakur[1]

[1]German integrative center for biodiversity research, Leipzig, DE, madhav.thakur@idiv.de

Soil invertebrate communities play a central role in the decomposition of soil organic matter and global carbon dynamics. Climate warming is argued to enhance decomposer activity, causing escalation of carbon losses from the soil and hence increasing positive feedbacks to climate warming. Climate warming may also coincide with prolonged droughts, which decelerate decomposition processes. Further, the consequences of climate warming effects on decomposer activity are likely to depend on seasonal variations in soil water availability. Thus, there is an urgent need for joint consideration of both climate change agents together with seasonal variations in soil water availability to better understand global change effects on decomposer activity. Here, we report a highly resolved temporal evaluation of decomposer activity in response to experimental warming and summer drought for three consecutive years from two independent sites in Minnesota, USA. Our results show that warming and summer drought additively and consistently decrease decomposer activity across sites and years. Moreover, we found that warming effects were neutral in wet seasons but particularly pronounced in drier seasons causing a net decrease in decomposer activity over the year. These results imply that climate warming can lower decomposer activity and thus reduce carbon losses from soil, particularly in drier soils.

O12 - Linking earthworm distributions with their effects on soil hydrological functioning

Anne-Kathrin Schneider[1], Loes van Schaik[1], Anne Zangerlé[1], Schröder-Esselbach Boris[1,2]

[1]Technische Universität Braunschweig, Braunschweig, DE, anne-kathrin.schneider@tu-braunschweig.de
[2]Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Berlin, DE

Earthworms as ecosystem engineers alter soil structure and related biogeochemical and soil physical processes through their burrowing behavior. The spatiotemporal distribution of earthworms is supposed to be linked with the spatiotemporal distribution of their functional effects, from bioturbation and seed dispersal to soil hydrological effects, for instance the density and effectivity of macropore systems for bypass flow, which has a large impact on solute transport. In order to investigate the link between earthworms' spatial and temporal distribution and their effect on macropore systems, (i) we surveyed earthworms and environmental factors in a mesoscale catchment in Luxembourg to determine the species' spatial distribution, and (ii) performed rainfall experiments using a dye tracer to obtain characteristic infiltration patterns. Our aims are (i) identifying the drivers of single earthworm species' distribution to map the spatial distribution of earthworms at catchment or landscape scale, and (ii) linking the spatial distribution of earthworms with their functional effects, i.e. occurrence and characteristics of macropore flow patterns, via transfer functions.

P1 - The role of mycorrhizae in tree diversity effects on ecosystem functioning and trophic interactions - The new experimental platform MyDiv

Olga Ferlian[1]

[1]iDiv Halle-Jena-Leipzig, Leipzig, DE, olga.ferlian@idiv.de

The positive relationship between biodiversity and ecosystem functioning is often attributed to complementarity among functional traits between different species, thereby e.g., increasing nutrient uptake. Mycorrhizae play an important role in plant nutrient and water uptake from soil and, consequently, in nutrient cycling of the whole system. Ectomycorrhiza and arbuscular mycorrhiza are characterised by fundamentally different strategies. It has often been found that in plant communities with highly diverse mycorrhizae the utilisation of soil nutrients is more efficient as compared to less diverse ones. Moreover, from a trophic perspective, mycorrhizal fungi serve as food source for fungal feeding soil fauna and, therefore, contribute substantially to carbon flow between trophic levels. However, the roles of the two major mycorrhizal types within the soil food web are still poorly understood. The new experimental platform MyDiv aims to study the influence of a crucial plant functional trait – type of tree mycorrhizal association – on the relationship between tree diversity and ecosystem functioning. The experiment focuses on the following main hypotheses: (I) AM fungi and EM fungi are a source of functional complementarity between different tree species. (II) Diverse mycorrhizal associations enhance the positive relationship between tree diversity and ecosystem functioning. (III) Tree communities with diverse mycorrhizal associations foster more diverse soil animal communities compared to communities of only one mycorrhizal type.

P2 - Multifunctional agricultural systems: earthworm diversity and ecosystem services after conversion to organic farming

Astrid Taylor[1], Fatima El Kosht[1], Jan Bengtsson[1], Dennis Jonason[2], Ingrid Öborn[1], Håkan Marstorp[1]

[1]Swedish University of Agricultural Sciences, Uppsala, SE, astrid.taylor@slu.se
[2]Stockholm University, Stockholm, SE

Due to their ability to enhance soil fertility and plant performance earthworms are integral for the sustainability of organic farming systems. Under conventional management, earthworm communities are often impoverished and information on potential time lags to supposedly more diverse and abundant earthworm communities when converting to organic management is lacking.

We studied the establishment of earthworm communities during the transition period after change from conventional to organic farming. In a field study in two Swedish landscapes, earthworm community variables and bioturbation – a proxy for ecosystem services delivered by earthworms – were related to a range of relevant soil ecosystem services in 6 conventional and 12 organic fields. The latter had been converted from conventional management <10 and >20 years prior to the study and farms with similar time since conversion were represented in both landscapes. Farms were selected along a gradient of landscape complexity to investigate if the earthworm communities were influenced by the available species pool in the surroundings, i.e. by the landscape context of the individual fields.

None of the measured earthworm community variables were significantly different between the two farming systems and no effect of time since transition was detected. Similarly, there was no effect of landscape complexity on earthworm communities. However, differences in abundance, biomass and bioturbation of individual ecological earthworm groupings could be related to differences in soil characteristics between the two landscapes.

The results demonstrate the strong influence of soil characteristics on earthworm communities and the inapplicability of the general terms 'conventional' and 'organic' farming as categories of soil management when considering soil biota. The investigations highlight the need for long term studies on the basis of a finer, more differentiated analysis of farm management practices and soil conditions.

P3 - Do plant exudates and/or plant-induced environmental gradients in the soil affect earthworm activity?

Elisabeth Ziss[1], Johannes Novak[2], Olaf Schmidt[3], Kerstin Michel[4], Andrea Watzinger[5], Bernhard Spangl[6], Johann G. Zaller[1]

[1]Institute of Zoology, University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, AT, elisabeth.ziss@students.boku.ac.at
[2]Institute of Animal Nutrition and Functional Plant Compounds, University of Veterinary

Medicine, Vienna, AT
[3]School of Agriculture and Food Science, University College Dublin, Dublin, IE
[4]Federal Research & Training Centre for Forests, Natural Hazards & Land, Vienna, AT
[5]Department of Health & Environment, Austrian Institute of Technology, Tulln, AT
[6]Institute of Applied Statistics and Computing, University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, AT

There is some evidence that earthworms show distinct preferences towards specific plant species. However, it is not well understood which factors actually influence the choice behaviour of earthworms. Recently it has been shown that, besides chemoreception, olfaction is also used by annelids to select food sources. Moreover, effects of allelochemicals, produced by living plants, on other plants, insects or microbes are well documented but not for earthworms. Here we test interactions of two model species: the plant *Calendula officinalis* (Asteraceae) and the anecic earthworm *Lumbricus terrestris* (Lumbricidae). First, in laboratory preference trials we tested the attraction of root exudates of *C. officinalis* for *L. terrestris*. Second, we set up a dual-choice microcosm experiment where we allowed for either below- and/or above-ground movement of earthworms towards plants to separate the relative importance of roots vs. shoots. In order to attribute earthworm responses to soil conditions modified by plants, we measured soil water content, soil temperature, electrical conductivity and soil CO_2 efflux in the different treatments. Results showed that earthworms were repelled by *C. officinalis* root extracts in the laboratory trials. Earthworm casts also contained traces of stable isotope labels applied to plant leaves. However, in soil microcosms, earthworm surface casting activity was neither affected by the presence of plants nor by earthworms possibility of either below- and/or above-ground movementor the measured soil parameters. In conclusion, results suggest that interactions in soil–plant–animal systems are complex and further research is needed to disentangle effects of live plant species on earthworms.

P4 - Are differences in intraspecific competition and interactions with below ground enemies explaining commonness of alien and native plant species ?

Gregor Müller[1], Mark van Kleunen[1], Wayne Dawson[1]

[1]University of Konstanz, Konstanz, DE, gregor.mueller@uni-konstanz.de

We used a common garden experiment with annual two-species communities to disentangle the roles of self limitation due to intraspecific competition and pathogenic soil fungi in explaining species success. Therefore, a set of 20 common and rare species of alien and native origin from three different families was cultivated over two generations in the botanical garden. Species communities were initially sown at two density levels (high/low) and were regularly treated with or without fungcide. Seeds of the species in the first year were collected and resown in the 2^{nd} year. We recorded the number of individuals per community in both years and ana-

lyzed the per capita poulation growth rate. Per capita population growth rates were significantly higher at low densities when treated with fungicide. Furthermore, alien species showed a higher per capita population growth rate at low density treaments than native species. In conclusion our study shows that fungicide addition positively affects population growth rates and thus highlights an important role of pathogenic soil fungi for plant species performance. However, fungicide treatment showed no effect at high densities, indicating that intraspecific competition was the prevailing meachnism of self limitation at high densities. Noteably, alien and native species, regardless of commonness, responded similarly to fungicde addition. Furthermore, alien species could capitalize more on lower intraspecific competition levels than natives.

P5 - Invasive Verbascum thapsus populations: Interactions with novel soil biota communities?

Julia Dieskau[1], Helge Bruelheide[1], Alexandra Erfmeier[2]

[1]Institut für Geobotanik, Martin-Luther-Universität, Halle-Wittenberg, DE
[2]Institut für Ökosystemforschung, CAU, Kiel, DE

Although evidence is provided that soil biota can strongly affect plant performance, knowledge on the effects of soil biota in the context of plant invasion is still scarce. While the net effect of soil biota on native species is generally being considered negative, the effect on invasive species is supposed to be a positive one (Reinhart & Callaway, 2006). These different patterns could be, e.g., due to a stronger positive effect of the soil biota in a plant species' invaded range compared to its native range (Enhanced mutualism hypothesis) or due to a release from pathogens (Enemy release hypothesis). Some studies used plant-soil feedback experiments to compare the effects of soil from the native and invaded range on different native and invasive species (Maron et al., 2014; Reinhart & Callaway, 2004). To our knowledge, there is no study including both soil from native and invaded ranges, and native and invasive populations of a successful plant invader in a common design.

We investigated the influence of soil biota on *Verbascum thapsus* in a combined plant-soil feedback and reciprocal transplant experiment. Seed material and soil from five *V. thapsus* populations each were sampled in the invaded (New Zealand) and native (Germany) range. A microbial wash was created from soil samples and subjected to four treatments of bactericide/fungicide application (reduction of bacteria, fungi, bacteria and fungi and control), and used for inoculation of sterilised soil. Plants of all ten origins were grown in soil biota communities originating from all populations and in all treatments of soil biota reduction (total n = 400 individuals). After three months of growth, we measured leaf and root traits and determined above and below ground biomass.

We found significant effects of seed origin for most of the traits. In particular, for some of the leaf traits, reduction of soil bacteria and fungi load significantly increased plant growth, while root length and specific root length was increased by a reduction of soil fungi. In addition, significant treatment x origin interactions in rosette area and leaf length hinted at adaptation of invasive populations to soil biota communities in their invaded range. These results indicate that rapid evolution in response to soil biota may have taken place during *V. thapsus* invasion in New Zealand.

P6 - Soil biogeochemical heterogeneity induced by the activity of the ant Lasius flavus

Antje Ehrle[1,2], Beate Michalzik[1], Susan Trumbore[2]

[1]Friedrich Schiller University, Jena, DE, antje.ehrle@uni-jena.de
[2]Max Planck Institute for Biogeochemistry, Jena, DE, antje.ehrle@uni-jena.de

Along with termites and earthworms, ants are important soil ecosystem engineers (Lavelle et al. 2006). As ants generate an environment inducing positive feedback for their colony development, their biogenic structures have a potentially large influence on the heterogeneity of the landscape with regard to micro morphology, soil chemistry and physics and vegetation patterns (Jouquet et al. 2006).

Within European grasslands the yellow meadow ant (*Lasius flavus* (Fabricius 1782)) is a common species (Seiffert 2007) that changes the character of the grassland by building prominent and abundant nest mounds of mineral soil. This often happens over extensive areas giving the whole phenomenon importance over large landscapes (Kovar et al. 2000).

We investigate how the activity of *Lasius flavus* influences the physical and chemical soil properties and element fluxes in two extensively grazed sheep pastures (Unstrut-Hainich district, Thuringia, Germany). The sites are situated on sedimentary rocks of the Mesozoic era (*Upper Muschelkalk*), partly covered by quaternary loess deposits.

During 2013 and 2014 we established four 10*10 m permanent study plots on these two sites. Since the installation 16 mounds of different development stages and 16 adjacent ant uninhabited spots are bi-weekly sampled for organic and inorganic soil compounds as well as fluxes of dissolved nutrients by glass borosilicate suction plates. Additionally, soil temperature and soil moisture are monitored in hourly intervals in close proximity to the suction plates.

The results of our soil water measurements indicate that the ant activity induce an increase in solution pH and a mean threefold rise of calcium and magnesium concentrations when compared to ant uninhabited spots. The linear calcium to magnesium relationship indicates a process driven through the weathering of calcareous bedrock material, transported upwards by the ant activity. When hourly mean soil temperatures under ant mounds and ant uninhabited spots are compared the ant mounds show a larger diurnal amplitude during the ant active season.

Thus, by enhancing the available of nutrients in soil solution and altering microclimatic conditions, ant mounds may promote soil biogeochemical heterogeneity with consequences for other species and processes in grassland ecosystems.

END OF SESSION 9

Session 10 - Ecology and evolution of asexual organisms
Short title: Asexual organisms

CHAIRS: ELVIRA HÖRANDL, PROF. DR. STEFAN DULLINGER

O1 - Asexuality in non-marine ostracods - patterns and processes

Isa Schön[1], Koen Martens[1]

[1]Royal Belgian Institute of Natural Sciences, Brussels, BE, isa.schoen@naturalsciences.be

Non-marine ostracods are small, bivalved crustaceans with the best fossil record of all recent arthropods. They show a wide variety of reproductive modes, ranging from being fully sexual over mixed reproduction to putative ancient asexuality (Martens et al. 2008). Mixed reproduction in ostracods is not variable through time as in cyclic parthenogenesis, but shows different geographic distributions of sexual and asexual populations, a pattern called geographic parthenogenesis. In Europe, asexual ostracod females occur everywhere, whereas sexual females and males are restricted to the Mediterranean region.

Eucypris virens, an ostracod with mixed reproduction and geographic parthenogenesis, and typically occurring in temporary, grassy pools in winter, has been the model species of the Marie-Curie Research and Training Network SEXASEX. We observed an exceptionally large genetic diversity with more than 40 cryptic species in Europe, the highest number ever reported from a freshwater invertebrate (Bode et al. 2010). Three of these cryptic species have recently invaded Western Australia (Koenders et al. 2012). No clear phylogeographic pattern can be found amongst the cryptic *E. virens* species and most species contain sexual as well as asexual populations, illustrating that asexuality is frequently originating in *E. virens*. Ecological research reveals that environmental parameters linked to the permanence of temporary pools correlate to the distribution of sexual *E. virens* (Schmitt et al. 2013). However, genetic factors must also be related to geographic parthenogenesis, as triploid asexual *E. virens* are more common in Northern Europe (Adolfsson et al. 2010). Within each ploidy class, there is quite some variation in genome size (Adolfsson et al. in prep.), which could have been caused by the independent accumulation of transposons and mutations in different asexual lineages since the transition to asexuality.

O2 - The eco-geography of sexual and apomictic polyploids in Potentilla puberula (Rosaceae)

Christoph Dobeš[1], Karl Hülber[2], Dietmar Moser[2], Andreas Tribsch[3]

[1]Austrian Research Centre for Forests, Vienna, AT, christoph.dobes@bfw.gv.at
[2]Department of Conservation Biology, Vegetation and Landscape Ecology, University of Vienna, Vienna, AT
[3]Department of Organismic Biology, University of Salzburg, Salzburg, AT

Intraspecific ploidy variation is an evolutionarily important phenomenon in numerous plant species. Polyploidization can be accompanied by with the evolution of apomixis (i. e. asexual reproduction via seeds). Variation in ploidy level and associated reproductive traits are of high relevance for the ecological and spatial distribution of cytotypes, and thus the eco-geography of a species. The eco-geography of sexual and apomictic ploidy cytotypes is driven by three principal factors: migration, habitat preferences or tolerances, and reproductive interaction among cytotypes. We studied the eco-geography of reproductively differentiated cytotypes in the herbaceous cinquefoil *Potentilla puberula* (Rosaceae) comprising five ploidy levels. The species shows reproductive differentiation into sexual tetraploid and apomictic penta- to octoploids cytotypes which coincided with ecological differentiation and mutual spatial exclusion. Within a latitudinal transect in the Eastern Alps covering 270 populations we quantified the relative contributions of migration from potential Pleistocene refugia, ecological sites conditions, and co-occurrence patterns of cytotypes to the current distribution of cytotypes by means of a variance partitioning algorithm. Traits and processes leading to mutual avoidance of cytotypes emerged as the main drivers accounting for the eco-geographic distribution of cytotypes, followed by the ecological preferences and the migration history of cytotypes. Specifically, tetraploids and higher ploids tended to spatially exclude each other, a pattern coinciding with ecological segregation and sexual-apomictic differentiation among these cytotypes. Three processes, which are all related to the reproductive system, hypothetically have caused the observed spatial exclusion: reproductive suppression (i.e., minority cytotype exclusion), reproductive transformation of sexuals by apomicts, and competitive replacement of cytotypes under contrasting ecological conditions. We developed computer simulations which are to be parameterized in an ongoing project with empirically and experimentally derived data pertaining to the reproductive system of sexual and apomictic individuals. Possible outcomes under various parameter settings are discussed.

O3 - Biogeographical patterns and ecology of sexual and agamospermous Limonium spp. from Eastern Atlantic coasts

Ana S. Róis[1,2], Sofia Conceição[1], Sílvia Castro[3], João Loureiro[3], Joana Costa[3], Dalila Espírito Santo[1], Ana D. Caperta[1]

[1]LEAF, Lisboa, PT
[2]Universidade Lusófona de Humanidades e Tecnologias, Lisboa, PT
[3]Centre for Functional Ecology, Lisboa, PT

Limonium Mill. (sea-lavenders, Plumbaginaceae) is a widespread genus of halophytes found in Atlantic coastal environments influenced by maritime winds and/or temporary soil submersion by seawater. Distinct species from diploid and tetraploid taxonomically complex groups (TCG) with sexual and/or asexual reproductive modes grow in maritime cliffs and saltmarshes exposed to human disturbance. Among them are the parallel-nerved diploid L. ovalifolium and tetraploid L. binervosum TCGs. In this study we addressed the (i) relationships between each species distribution patterns and habitat preferences; (ii) geographic patterns and constancy of ploidy levels within populations over the entire distribution range of each TCG; and (iii) putative modes of reproduction (sexual and/or asexual). Geographical distribution, ecological requirements and cytotype diversity were assessed in a representative number of natural populations of each TCG. Floral polymorphisms and reproductive modes were analysed in individuals from garden collections. Our findings revealed habitat specificity for both diploid and tetraploid species, although tetraploids can be found in a wider variety of habitats, possibly associated to a greater ecological plasticity in comparison with diploids. In general, a constancy in the ploidy level was observed in the populations analysed and across the entire range from both TCG. We also provided evidence that diploids are predominantly sexual while tetraploids are mostly apomicts. Furthermore, diploid sexuals were more widespread along the Portuguese coasts than tetraploid apomicts, which have a broader distribution to higher latitudes. In conclusion, our results reveal a pattern of „geographical parthenogenesis“ which is not strictly related with ploidy levels; rather it appears that latitudinal ice sheet limits during the quaternary glaciations were involved in the observed geographical pattern.

O4 - Effects of altitude on polyploidy and apomixis: a case study on the alpine plant species Ranunculus kuepferi

Christoph Carl-Friedrich Schinkel[1], Bernhard Kirchheimer[2], Simone Klatt[1], Agnes Dellinger[2], Manuela Winkler[3], Stefan Dullinger[2], Elvira Hörandl[1]

[1]Department of Systematics, Biodiversity and Evolution of Plants, Georg-August-University of Göttingen, Untere Karspüle 2, 37073 Göttingen, DE, christoph-carl-friedrich.schinkel@biologie.uni-goettingen.de
[2]Department of Botany and Biodiversity Research, University of Vienna, Rennweg 14, 1030 Vienna, AT
[3]Centre for Global Change and Sustainability, University of Natural Resources and Life Sciences, Vienna, Borkowskigasse 4, 1190 Vienna, AT

Apomictic plants expand their geographical distributions more to higher altitudes and latitudes compared to their sexual progenitors. It was so far unclear whether this tendency is related to mode of reproduction itself or represents a side effect of polyploidy. Polyploidy is thought to infer fitness advantages and a higher vigor which would enable plants to perform better under more extreme climatic conditions.

We analyzed 81 populations of *Ranunculus kuepferi* from the whole distribution area in the Alps with respect to ploidy level and mode of reproduction. Seed set and vegetative growth were measured as fitness parameters. All parameters were correlated to altitude, temperature and precipitation.

Flow cytometric seed screening revealed sexuality (mean 88.9%) and facultative apomixis in diploid populations, while tetraploid populations are facultative (mean 65.4%) to obligate apomictic. The tetraploid level correlated significantly to higher altitudes and to colder temperatures. Diploids showed higher seed set and increased vegetative growth compared to tetraploids.

The tendency of apomicts towards higher altitudes and colder climates can rather be attributable to effects of polyploidy than to apomixis. Performance of tetraploids may relate to cold tolerance rather than to general fitness. In fact, facultative apomixis may aid range expansions over large distances.

O5 - Complex patterns of niche differentiation in sexual and asexual plants: a case study on Ranunculus kuepferi

Bernhard Kirchheimer[1]

[1]Department of Botany and Biodiversity Research, University of Vienna, Vienna, AT, bernhard.kirchheimer@univie.ac.at

Polyploidization is an important mechanism of adaptation and speciation in plants but the establishment of new polyploids might be thwarted by competition with surrounding diploids. Niche differentiation has been suggested to be important for overcoming competitive resistance of ancestral cytotypes but the importance of this mechanism has recently been challenged. For those cases were polyploidization is accompanied by apomixis this phenomenon has been termed “geographical parthenogenesis”.

In our study we ask whether (1) sexuals and asexuals differ in the position of their niche optima and/or in their niche breadths across their respective ranges; (2) whether these differences vary when comparing sympatric and allopatric ranges; (3) whether results based on GIS-derived coarse-grained environmental data are consistent with results based fine-grained environmental data derived from a large set of vegetation plots.

We focus on one particular model system (*Ranunculus kuepferi*) to develop an in-depth study of niche differentiation between sexual diploids and asexual tetraploids, which is based on recent methodological progress using data from consistent sampling and cytotype determination across (nearly) the whole spatial range of the species complex. Our study is the first to assess detailed niche changes between di- and polyploid cytotypes of a given species by contrasting sympatric with allopatric situations and by comparing results obtained with coarse- and fine-grained environmental variables.

Our results demonstrate that the environmental niche of the asexual *R. kuepferi* differs from the niche of its sexual ancestor. When focussing on the entire geographical ranges of both cytotypes, this difference appears to be mainly driven by a shift of the niche optimum without a significant change in niche breadth. Analysing the subset of sympatric and allopatric populations separately shows that the asexuals‘ realized niche is narrower in the sympatric region, but was significantly broadened in the allopatric range.

Finally, our analysis revealed partly inconsistent results at macro- and micro-environmental scales, in particular with respect to changes in niche breadth. As a corollary, basing analyses of niche differences on large-scaled climatic data might lead to erroneous conclusions.

O6 - Geographical parthenogenesis in Hieracium alpinum (Asteraceae): Can the Red Queen Hypothesis contribute to explain the found patterns?

Matthias Hartmann[1], Patrik Mráz[1], Pavel Zdvořák[1], Michal Stefanek[1], Jindřich Chrtek[1]

[1]Charles University, Prague, CZ, m.hartmann301187@gmail.com

Geographical parthenogenesis, the shift of asexuals towards higher altitudes, northern latitudes, more extreme habitats and occupation of larger areas when compared with their closely related sexual relatives, is still poorly understood. Several hypotheses have been proposed to explain such patterns with lacking empirical evidence due to limited number of studies. According to the Red Queen hypothesis, sexuals should have an evolutionary advantage in habitats with many biological interactions. Consequently, asexuals should have an advantage at the margins or extremer habitats where biological interactions are less important. *Hieracium alpinum* is a herbaceous arctic-alpine insect-pollinated species growing in tundra habitats from Greenland to the mountains in Central and Eastern Europe. While the sexuallyreproducing, diploid plants occur only in a small isolated area of the Eastern and Southern Carpathians, the apomicticallyreproducing triploids occupy the remaining and much larger part of the range. Biotic interaction data based on seed herbivores, co-occurring plant species composition and vegetation density revealed no differences between the ploidies (and thus the mode of reproduction) but strong differences between populations. Consequently, our findings do not support the Red Queen hypothesis for explanation of geographical parthenogenesis and prevalence of asexual populations in *H. alpinum*. Other alternative explanations are briefly discussed.

P1 - Effects of environmental stress on mode of reproduction

Simon Klatt[1], Franz Hadacek[1], Ladisav Hodac[1], Diego Hojsgaard[1], Elvira Hörandl[1]

[1]University of Göttingen, Göttingen, DE, elvira.hoerandl@biologie.uni-goettingen.de

In flowering plants, apomixis, the asexual reproduction via seed, is usually facultative, which means that both sexual and asexual offspring can arise from the same

mother plant within the same offspring generation. Frequencies of facultative sexuality appear to show a high variance according to abiotic environmental conditions. This variation may also contribute to geographical patterns of apomictic plants. Here we present experimental work on hexaploid clone-mates of *Ranunculus auricomus* to test the hypothesis that (1) clone-mates produce higher frequencies of sexual offspring under light stress; (2) plants change under stress conditions their expression of ROS-scavenging secondary metabolites. (3) stress-response is not genotype specific and consequently rather due to phenotypic plasticity or under epigenetic control. Plants produced in progeny arrays were genotyped with six microsatellite markers developed from an RNAseq dataset, and treated in climate growth chambers under different photoperiods (8hs and 16hs). We screen for frequencies of aposporous initials vs. functional megaspores via DIC microscopy, and for sexual vs. apomictic seed formation via flow cytometric seed screening. Phenolic metabolites in flowering buds are being screened via HPLC-DAD. Genoytping is performed with microsatellite markers. Plants express higher frequencies of sexuality under light stress and later composition of secondary compounds, but variation is not genotype-specific. Results will be discussed with respect to evolutionary consequences and inference for understanding biogeographical patterns of apomixis.

P2 - Floral heteromorphisms and phylogeographic patterns of halophytes Limonium vulgare and related taxa in coastal Portugal

Ana S. Róis[1], Flávio Sádio[2], Ana Cortinhas[2], Pedro Arsénio[2], José Carlos Costa[2], Dalila Espírito Santo[2], Ana D. Caperta[2]

[1]Universidade Lusófona de Humanidades e Tecnologias, Lisboa, PT, rois.ana@gmail.com
[2]LEAF/ISA, Lisboa, PT

Limonium vulgare Mill. (Plumbaginaceae) and other closely related taxa (Limonium maritimum and Limonium narbonense) form a markedly biodiverse halophytic plant group distributed throughout European Atlantic and Mediterranean coastal regions. In Portugal, most of these species are found together in mixed populations, and typically occur in saltmarshes flooded for a more or less long period by brackish water derived from autumn and winter fall, becoming completely dry during summer. Except for L. maritimum, the other species have been described as being obligate outcrossers. In this study, we investigated: (1) the floral polymorphisms and (2) the phylogeographical patterns of Limonium vulgare and related taxa which grow in sympatry as well as in allopatry using the maternally-inherited chloroplast trnL intron and trnL-trnF intergenic spacers; and examined (3) potential correlations of geographical patterns with species differentiation. Flower heteromorphies analyses revealed the existence of two flower morphs (pin and thrum) and two pollen-stigma morphs in most populations. However, in one population all individuals exhibited homostylic flowers with a unique pollen-stigma morph. Genetic analyses showed that haplotype diversity varied among and within populations, although some populations presented only one haplotype. Network analysis revealed haplotype sharing within and among species' populations, although no correlation was detected between geographic origin and chloroplast haplotype distribution across Portugal coast. Our results provide evidence that these taxa are both poorly morphologically and genetically differentiated.

END OF SESSION 10

Session 11 - Integrating the effects of variability into ecological models
Short title: Variability in ecological models

CHAIRS: BRITTA TIETJEN, KATRIN M. MEYER

O1 - Individual variability in marine models: lessons from Antarctic krill (Euphausia superba) models

Jürgen Groeneveld[1], Karin Johst[1], So Kawaguchi[2,3], Bettina Meyer[4,5], Mathias Teschke[4], Grimm Volker[1,6,7]

[1]Helmholtz Centre for Environmental Research - UFZ, Leipzig, DE,
juergen.groeneveld@ufz.de
[2]Australian Antarctic Division, Kingston, AU
[3]Antarctic Climate and Ecosystem Cooperative Research Centre, Hobart, AU
[4]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, DE
[5]Carl von Ossietzky University, Oldenburg, DE
[6]University of Potsdam, Potsdam, DE
[7]German Centre for Integrative Biodiversity Research (iDiv), Leipzig, DE

Individual based models are widely used and accepted to address research questions in terrestrial systems. The majority of ecological marine models does not work at the individual level at all and if so the tradition is much more to treat individuals of a certain species as identical particles that are passively transported by currents in so called Lagrangian models. This is particular true as individuals become small and abundant as the Antarctic krill (*Euphausia superba*) which is the key species of the Southern Ocean. Given the species importance both for the Antarctic food web and for commercial fishery several krill models have been independently developed. This allows us to present for a set of different model types how they have dealt with individual variability. In addition we will also present our own simulation model that has been developed in the PolarTime project. The model addresses the question how individual krill will be affected by global change if its seasonal physiological rhythm is driven by environmental factors such as day length. In a previously published study we have not considered individual variability in our model. That allows us now to assess how individual variability will affect the ability of krill to adapt to global change. In particular we will focus on the response of krill to environmental drivers such as day length. This driver is supposed to switch metabolic activity in krill, i.e. changing from low metabolic activity during winter to high metabolic activity in summer. These physiological seasonal rhythms have evolved that krill can persist in the harsh environment of the Southern Ocean, i.e. to synchronise its metabolic activity with food availability and benign environmental conditions. However, with global change individual plasticity may be key for the adaptation potential of krill to cope with unprecedented environmental conditions, e.g. changes in the sea ice cover dynamics.

O2 - Modelling insect populations - the importance of individual variability

Oliver Jakoby[1], Carlo Albert[2], Beat Wermelinger[1]

[1]Swiss Federal Research Institute WSL, Birmensdorf, CH, oliver.jakoby@wsl.ch
[2]Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, CH

Keywords: Time-varying distributed delay model, Bayesian model calibration, European spruce bark beetle, phenology, forest pest management.

Individual and environmental variability are crucial factors for population dynamics of insect populations. Nevertheless, some modelling studies on forest insect phenology neglect individual variability by simulating merely the development of average individuals as representative of the whole population. Depending on the particular research question, this might not be sufficient. In this study, we demonstrate how to include variability in phenology models for insects by example of a forest pest species and particularly highlight the benefit for management practice.

We developed a time-varying distributed delay model for the European spruce bark beetle (*Ips typographus*). This model accounts for the variability in individual development rates and in environmental variables, such as temperature. The parameters of the model were estimated using Bayesian inference, which has the advantage of taking parameter uncertainty into account.

We show that variability is essential to evaluate the development of populations, patterns of infestation periods and winter mortality as it enables the estimation of the density distribution of different developmental stages and the population's flight pattern. Particularly, the temporal distribution of beetle flights was highly beneficial for providing the model results on an online information platform supporting forest management (www.borkenkaefer.ch), as this pattern is well known in forest practice.

Altogether, we demonstrate how to incorporate, calibrate and analyse individual variability in phenology models of insects. This approach provides benefits for risk management of pest insects and supports the transfer of scientific knowledge into forest practice.

O3 - Response of vegetation composition towards grazing under climate change - the effect of increasing plant diversity in a savanna model

Tong Guo[1]

[1]Freie Unviersität Berlin, Berlin, DE, tongg@zedat.fu-berlin.de

1. The complex interactions among plants, soil and climate in semi-arid savannas make it difficult to predict the change of vegetation structure. Hence it is urgent for us to understand the response of vegetation composition to the changing environment. Until now, ecohydrological models of savanna systems have aggregated

plant species to very broad plant functional types (PFTs). Similar PFTs are generally characterized by mean trait values, and ignorance of the variability between similar PFTs may hinder our understanding on the impact of ecological processes on the vegetation composition.

2. In this study we extended and parameterized the ecohydrological savanna model EcoHyD originally considering only three PFTs (perennial grasses, annuals and woody plants) to assess the change of a more diverse plant type community along environmental gradients. The group of perennial grasses was represented in more detail by including typical trade-offs among plant traits to describe different grass types.

3. The simulation results show increased grazing intensity facilitates the dominance of the fast-growing and short-lived grass type whilst in the absence of grazing the composition of grass community is explicitly interpreted by the contribution of the higher-palatability and faster-growing competitor. On the other hand, inter-annual change of precipitation conspicuously reshapes the structure of grass community compared to the intra-annual change. In addition, we found that larger trait differences between grass sub-types result in the alteration of vegetation structure and water distribution in the soil layers.

4. Our approach could show that the effects of trait variation within the usually applied „meta“ PFTs (woody plants vs. grasses vs. annuals) will potentially allow for a more realistic simulation of ecosystem responses to global change. Hence, by including sub-type diversity, savanna vegetation models will be able to address pressing questions related to biodiversity, especially with regard to certain ecosystem functions and services.

O4 - Exploring the predictability of macroscale patterns from individual properties

Miriam Grace[1], Marc-Thorsten Hütt[1]

[1]Jacobs University Bremen, Bremen, DE, m.grace@jacobs-university.de

In ecology, variability of individuals in a population plays a critical role in determining asymptotic population states, which are expected to be subject to evolutionary optimisation. On an abstract level, it has been shown that a heterogeneous population whose individual properties are subject to temporal variation (along a ‘developmental path’) can establish self-organised spatiotemporal patterns from a homogeneous initial state. We explore such routes to pattern formation in a generic model of an excitable medium, a lattice of diffusively coupled FitzHugh–Nagumo oscillators, as well as in classic ecological models. The predictability of spatiotemporal patterns from individual properties provides insights into the dynamics of the system and the pattern formation process, while relating information at the microscopic and macroscopic scales. We investigate pattern predictability using a variety of scenarios for imposing variability. These include systems where variability is a function of the desynchronization and drift speed of individuals along a developmental path. Finally, we consider the specific applications of a pattern predictability paradigm to ecology.

P1 - Lessons to be learned from empirical tree mortality models - A model assessment

Lisa Hülsmann[1,2], Peter Meyer[3], Harald Bugmann[2], Peter Brang[1]

[1]WSL Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf, CH, lisa.huelsmann@wsl.ch
[2]ETH Swiss Federal Institute of Technology, Zürich, CH, lisa.huelsmann@wsl.ch
[3]NW-FVA Northwest German Forest Research Institute, Göttingen, DE

During the last two decades, the number of empirical models predicting the mortality of individual trees substantially increased. However, the approaches used vary largely, and the varying outcomes call for caution in applying those models across larger areas and over longer time spans, including future climatic conditions. Due to large variability of mortality patterns and limited knowledge on the generality of derived mortality functions, modelling tree death in dynamic vegetation models remains an unsolved problem in the simulation of stand dynamics, which severely restricts the prediction of future forests and forest landscapes. In this study, we use an extensive inventory dataset from natural forest reserves in Switzerland and Germany to systematically assess the performance of previously developed mortality models for main European tree species. We analyze models calibrated using covariates for tree size and growth, competition and site characteristics derived from inventory datasets from all over Europe. The models are compared based on their ability to predict accurate mortality rates and to discriminate living and dead trees when validated with data from the reserve network. The achieved performance is examined as a function of model characteristics such as extent of calibration data, spatial and temporal data coverage and the covariates considered. Based on the findings, it is possible to derive the degree and the sources of variability in mortality predictions. The results provide guidance for selecting modeling strategies for future mortality functions in terms of complexity, data sources and covariates allowing for improved tree mortality predictions in dynamic vegetation models.

P2 - A gene flow model for Populus under variable climatic conditions

Felix Staeps[1], Birgit Ziegenhagen[1], Ronald Bialozyt[1,2]

[1]Philipps-Universität, Marburg, DE, felix.staeps@posteo.org
[2]Nordwestdeutsche Forstliche Versuchsanstalt, Göttingen, DE

Short rotation plantations of manifold poplar hybrids are about to be established in great scales in Germany, posing even further endangerment by introgression for the already threatened black poplar (Populus nigra), which has been co-occurring for over 100 years with planted P. deltoides x P. nigra hybrids (P. x canadensis) in Europe. Numerous authors reported back crosses observed in the landscape, but this has not yet led to a coalescence into one species, which is suspected to originate from the exiguity of overlapping flowering time. However, heavily increasing flowering overlap has been observed between P. nigra and the hybrids after extremely long winters. These observations correspond to the current hypothesis that phenological behavior, although highly variable within the population, is strongly linked to environmental conditions - and consequently subject to climate change. As hybrids intended for plantations are bred for specific traits and planted as large clonal colonies, their genetic variability is considerably low, and gene flow with them could lead to genetic drift and weaken the genotypic plasticity of native poplars.

We built an agent-based model to explore such gene flow and its potential consequences for P. nigra. The species status of poplar agents in our model is determined by the composition of species specific parameters modeled from real-world genetic markers. This way, agents form species specific traits connected to abiotic environmental conditions. The key feature, however, is a set of inheritable behavioral traits that control the time frames of pollen and seed dispersal. As observed in the flowering phenology of P. x canadensis populations, hybrid agents display flowering behavior that is intermediate between both parental species. By simulating the gene flow between P. nigra and P. x canadensis over generations, this model will enable an assessment of the threats introgression may pose to the persistence of P. nigra in our landscape.

END OF SESSION 11

Session 12 - A social-ecological systems perspective on biodiversity conservation

Short title: A social-ecological perspective on conservation

CHAIR: JOERN FISCHER

O1 - Beyond dualism in biodiversity conservation: Toward acknowledging the diversity of values, institutions and knowledge

Berta Martín-López[1,2]

[1]Social-ecological Systems Laboratory, Autonomous University of Madrid, Madrid, ES, berta.martin@uam.es
[2]Environmental Change Institute, University of Oxford, Oxford, UK, berta.martin@uam.es

The discipline of conservation biology has evolved on the basis of how relationships between people and nature are framed, moving from safeguarding species and habitats toward an integrated perspective that recognizes that human societies are highly interconnected with the biophysical life-support system. The social-ecological systems frame emphasizes the importance of cultural and institutional structures for developing sustainable and equitable management. In fact, under the social-ecological systems framework, three conservation challenges emerge: (1) to recognize the multiple values of biodiversity and arguments for its conservation, (2) to acknowledge that complex systems, such as social–ecological systems, require institutional diversity to be effectively managed, and (3) to go beyond scientific disciplines towards a real transdisciplinary science, which integrates non-scientific knowledge (i.e., indigenous, local or traditional knowledge). To face the aforementioned challenges, we should transcend the antagonistic discourse of biodiversity values in Western societies based on intrinsic vs instrumental values and to recognize the myriad ways of understanding biodiversity by multiple stakeholders. Further, we ought to move beyond conservation vs. development paradigm and recognize the diversity of institutions (i.e., informal, formal rules and markets) at different organizational scales. Finally, if biodiversity problems are socially created, conservation science should transcend the distinction between natural and social sciences and the knowledge construction process might integrate diverse stakeholders' beliefs and perceptions.

Nowadays, there is an opportunity to further explore this framework under the umbrella of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) as it acknowledges the principles of value-pluralism and institutional diversity, as well as it embraces a variety of knowledge systems.

O2 - Characterising social-ecological units to inform biodiversity conservation in farming landscapes

Jan Hanspach[1], Jacqueline Loos[1], Ine Dorresteijn[1], David Abson[1], Joern Fischer[1]

[1]Leuphana University Lüneburg, Lüneburg, DE, hanspach@leuphana.de

Farming landscapes present an arena where human activities and ecological processes are tightly interlinked. Especially landscapes shaped by low intensity farming often support high biodiversity while also providing goods and services to local people. However, the dual process of land use intensification and abandonment is threatening species and ecosystems in many low-intensity farming systems. To facilitate effective biodiversity conservation in such systems a holistic understanding of local characteristics and social-ecological dynamics is critically important.

Here, we report on an original, regional scale dataset on richness patterns, land use, topography and socio-demographic variables in a 7440 km² study area in Southern Transylvania (Romania). We surveyed the distribution of breeding birds, butterflies, and vascular plants in 150 sites distributed across arable land, pasture and forest around 30 randomly selected villages. We modelled species richness using generalized linear mixed effect models and predicted it to the whole study area. Richness then was aggregated to the village level and related to land use, topographic and socio-demographic characteristics of the villages using multivariate methods. Based on this, we developed a typology of villages, and for each “village type” assessed the threats and opportunities for biodiversity conservation.

Our findings highlight the importance of pursuing conservation strategies that consider local social and ecological characteristics. Our approach can be applied to other systems, and thus could help inform biodiversity conservation in farming landscapes around the world.

O3 - Resilience-based perspectives to guiding High-Nature-Value farmland through socioeconomic change

Tobias Plieninger[1]

[1]University of Copenhagen, Copenhagen, DK, tobias.plieninger@ign.ku.dk

Global environmental challenges require approaches that integrate biodiversity conservation, food production, and livelihoods at landscape scales. This paper reviews the approach of conserving biodiversity on “high-nature-value” (HNV) farmland, covering 75 million ha in Europe, from a resilience perspective. Despite growing recognition in natural resource policies, many HNV farmlands have vanished, and the remaining ones are vulnerable to socioeconomic changes. Using landscape-level cases across Europe, the paper considers the following social-ecological system properties and components and their integration into HNV farmland management: (1) coupling of social and ecological systems, (2) key variables, (3) adaptive cycles, (4) regime shifts, (5) cascading effects, (6) ecosystem stewardship and collaboration, (7) social capital, and (8) traditional ecological knowledge. It is argued that previous conservation efforts for HNV farmland have focused too much on static, isolated, and monosectoral conservation strategies, and that stimulation of resilience and adaptation is essential for guiding HNV farmland through rapid change.

O4 - Social values for green open space and their implications for urban biodiversity management

Christopher Ives[1,2]

[1]Leuphana Universität, Lüneburg, DE, christopher.d.ives@gmail.com
[2]RMIT University, Melbourne, AU, christopher.d.ives@gmail.com

Urban and suburban landscapes are ideal for studying social-ecological systems, as biodiversity and human-wellbeing outcomes are intimately connected. Spatially-mapped social values can be especially useful for landscape management in this context. In this study we explored the relationship between physical attributes of green open spaces and their social values in the Lower Hunter Valley – an urbanising region of east coast Australia. We employed a Public Participation GIS survey design, which enabled participants to mark their values for specific open spaces on interactive paper maps. Data were collected from 418 respondents from four suburbs. Statistical modelling revealed that park characteristics influenced mapped social values in different ways. The amount of vegetation cover was generally important, but some value types (e.g. nature value) peaked at higher levels than others (e.g. social interaction value). Interestingly, municipal planning category did not always reflect closely the values people assigned to parks, with 'natural' areas being valued in a similar way to 'general' open spaces. The co-occurrence of values in green spaces was assessed to provide information on value compatibility. In addition, the value orientations of individual respondents were related to the values they assigned to their local environment. Results from this study demonstrate that open space values are a function of both the physical environment and the characteristics of individuals. This type of information provides a useful tool for the management of social-ecological systems as it can inform the compatibility between social values and biodiversity conservation actions and outcomes.

O5 - Integrating habitat restoration and livestock grazing - a novel agri-environment scheme from southeastern Australia

Dean Ansell[1]

[1]Australian National University, Canberra, AU, dean.ansell@anu.edu.au

In many agricultural landscapes, land clearing has caused environmental degradation that impacts not only on biodiversity and other ecosystem services, but also agricultural production. Carefully designed ecological restoration has the potential to provide economic benefits while improving biodiversity values. Whole-of-Paddock Rehabilitation (WOPR) is a novel agri-environment scheme in Australia working to integrate agricultural production and ecological restoration. WOPR focusses on the restoration of woody vegetation in productive grazing landscapes, using a planting design that balances factors that drive biodiversity response to restoration, such as the size, shape and habitat complexity of the site, with the needs of continued livestock grazing.
Growing from a collaboration between an enterprising farmer and non-government organisation, the scheme has grown significantly since its inception in 2008, with more than 80 enrolled fields across Australia‘s southeast. The size of fields has more than doubled, now averaging 38ha, and fields in excess of 100ha have recently been enrolled. Analysis reveals the superior cost-effectiveness of the scheme compared to prevailing approaches to habitat restoration in agricultural landscapes, driven largely by the emphasis on large fields, use of existing farm configuration, and the reduced opportunity costs to the farmer.

The scheme fills an important gap in the conservation of farmland biodiversity in grazing-dominated systems, and provides a strong example of the integration of social, economic and ecological values. Despite the success of the scheme to date, several challenges are identified, including limited transferability to other agricultural systems, uncertainty over long-term environmental benefits, and funding security. These challenges will be described, along with the scheme‘s critical design elements, with a focus on the socio-ecological dimension of habitat restoration on farmland.

O6 - Patterns, processes & drivers - how interconnected social-ecological systems shape landscapes in the Okavango catchment

Manfred Finckh[1], Cynthia Erb[1], David Frantz[2], Rasmus Revermann[1], Achim Röder[2], Anne Schneibel[2], Marion Stellmes[2]

[1]Biodiversity, Evolution and Ecology of Plants, Biocentre Klein Flottbek, University of Hamburg, Hamburg, DE, manfred.finckh@uni-hamburg.de
[2]Department of Environmental Remote Sensing and Geoinformatics, Trier University, Trier, DE

The Okavango catchment is still one of the most intact river basins in Africa. However, since the last decade it started to undergo increasing transformation. The Future Okavango project (TFO) aimed at analysing the processes and drivers of change, looking at social-ecological systems in four research sites and in the basin as a whole, combining transdisciplinary field data sampling with earth observation imagery and spatial modelling.

Land use change patterns reveal underlying processes and driving forces at different scales and levels of decision making. At local scale the expansion of fields into natural ecosystems is mostly driven by low-yield smallholder agriculture. Decisions on land allocation are in most areas still made by traditional authorities.

Road infrastructure facilitates the commodification of collective ecosystem goods like charcoal or bush meat. Thus, roads predefine axes of transformation and degradation. While planning decisions are taken at government level, one major driver of the observed transformations is the poverty of local communities aspiring at improved livelihoods and access to modern consumer goods.

However, macro-infrastructure projects are also gateways for agro-industrial projects, driven by national elites and international capital. Large irrigation projects develop on formerly collective lands, causing complete ecosystem transformations and considerable social externalities. Large projects are backed by discourses on National Food Security or Economic Development.

International discourses (e.g. on conservation) also feed back into national decision making. Conservation areas safeguard tracts of land against transformation, but local community interests are not always taken into account and conservation projects may divert exploitation pressure to neighbouring areas.

Results show that resource governance, decision making and economic interests at different levels shape landscapes and enhance dynamics of their persistence, degradation and transformation. While processes at local level tend to be patchy and diffusely degrading, at higher levels they amount to large scale transformations. The spheres of different social-ecological (sub-)systems overlap spatially and in hierarchy, with multiple interconnections and trade-offs between them.

O7 - Relationships between large mammal diversity and wildlife tourism in Southern Africa

Ugo Arbieu[1,2], Claudia Grünewald[1], Matthias Schleuning[1], Katrin Böhning-Gaese[1,2]

[1]Senckenberg Biodiversity and Climate Research Centre, Frankfurt am Main, DE
[2]Department of Biological Sciences, Goethe Universität, Frankfurt am Main, DE,
ugo.arbieu@senckenberg.de

Cultural Ecosystem Services (CES) remain understudied in comparison to other ecosystem services. In national parks, biodiversity has the potential to provide CES by attracting tourist visitors, thus contributing to human well-being as well as local development. Studies that attempt to quantify the link between biodiversity and CES tend to either restrict analyses to rare or charismatic species, or focus on economic valuation. In this study, we counted visitor vehicles and large mammals along 5 km touristic road transects (overall 196 transects) in four protected areas (Kruger, Chobe and Etosha National Parks and Hluhluwe-Imfolozi Game Reserve) in three countries of Southern Africa (Botswana, Namibia and South Africa). We tested the effect of several biodiversity metrics on vehicle numbers along the road transects, using generalized linear mixed-models (Poisson regressions) and controlling for possible effects of park infrastructure. We found that most biodiversity metrics had a significant positive effect on vehicle numbers. Overall mammal abundance and species richness had the strongest effect on vehicle numbers across the four parks. Predator abundance and richness were the only biodiversity metrics that had a consistently positive effect on vehicle numbers across parks. In contrast, the effects of other biodiversity metrics, such as phylogenetic diversity, the richness and abundance of ungulates (all species, rare species only), threatened species (according to IUCN) and big five species were park-specific. These results suggest that biodiversity positively influences tourist behaviour in African national parks, albeit its effect tends to be park-specific, and that charismatic species might not be the only drivers of CES in social-ecological systems. Our study provides a successful and repeatable methodology that could open fields for more quantitative analysis on the relationship between biodiversity and CES in national parks and beyond.

O8 - Impacts of socioeconomic development dynamics (or global change) on biodiversity and traditional land management – problems and opportunities in multifunctional agrarian landscapes in Asia

Vera Tekken[1], Joachim H. Spangenberg[2], J. Settele[2]

[1]Department of Geography and Geology, University of Greifswald, Friedrich-Ludwig-Jahn-Str.16, D-17487 Greifswald, Germany
[2]Helmholtz Centre for Environmental Research – UFZ, Dept. of Community Ecology, Theodor-Lieser-Str. 4, 06120 Halle, Germany

In South-East Asia, traditional land management has shaped cultural landscapes and created specific agrarian biodiversity. Recently, increasing development pressures and societal dynamics have triggered an agricultural intensification of small-scale (subsistence systems, smallholders) production systems so far hardly affected by the Green Revolution. The resulting low-biodiversity, input-intensive agriculture leads to impacts such as the reduction of agricultural crop and natural species diversity, the modification of characteristic landscape patterns by land conversion, the disappearance of biotopes, loss of cultural diversity and important resource management knowledge, and potentially severe consequences for human well-being.
The presentation focuses on current environmental, social-economic and cultural drivers and impacts related to biodiversity degradation caused by changing land use, exemplified by South East Asian agrarian rice landscapes. Based on regional examples and empirical case studies and framed by the Ecosystem Services concept we look at the impacts of socio-economic dynamics on a) nutrient cycles & crop production, b) on biocontrol & pollination, and c) on cultural identity and landscape aesthetics. Opportunities for ecologically and economically efficient agricultural intensification strategies, which include the traditional knowledge of the local population and contribute to human well-being, are outlined.

O9 - Dynamic Interactions, Socio-economic activities and Their Environmental Impacts in the Muyong-Payoh systems of Banaue, Ifugao, Philippines

Damasa Macandog[1], Milben Bragais[1], Marc Brian Manlubatan[1], Lester Ryan Mojica[1], Mark Anthony Rabena[1], Roxanne Banalo[1]

[1]University of the Philippines Los Banos, College, Laguna, PH, demi_macandog@yahoo.com

*Muyong*refers to forest or woodlot planted with indigenous timber, fruit trees, and natural vegetation maintained above the *payoh* terraces. *Muyong* plays a critical role in sustaining the land-use system as it is the source of irrigation water for the *payoh* terraces and italso protects farms in the downslope from soil erosion and water runoff, and maintains soil fertility and plant biodiversity.

Participatory Rural Appraisal (PRA) activities were conducted in Banaue, Ifugao to gather information about the dynamic interactions, socio-economic activities and its environmental impacts in the *muyong-payoh* systems. Sixty participants joined the various PRA activities. During the 1950s, the trees were cut down in the *muyongs* to support the budding wood carving industry. This coupled with rampant *shifting cultivation* farming resulted in water shortage and decrease in bird population.

From their introduction in the 1970s, high-yielding rice varieties were more commonly planted in the *payohs*. Alongside new rice varieties, the golden fish was introduced which was observed to cause the decline in mudfish, Japanese fish, *tilapia,* and other edible fish populations.

From the 1990s onwards, the major problems in the *muyong* were decrease in indigenous tree density and introduction of exotic tree species, increasing soil erosion, decreasing biodiversity and diminishing water quantity flowing down from the headwaters. The most pressing problem encountered in the *payoh* rice fields were the reduced rice yield, presence of pests and diseases, soil erosion, collapse of terrace walls, and poor irrigation. Decreasing farm labor is another problem among the communities and manifests in the reduced number of *payoh* terraces being maintained and cultivated. Disintegration of cultural practices can be attributed to the younger generations little or no interest in observing their traditions.

The proposed solutions to mitigate these problems and to sustain the *muyong* forest include policies on the introduction of exotic species and reforestation using indigenous species. In the *payoh* system, capacity-building through seminars on integrated pest management, repair of the terrace‘s walls and use of tractors as a substitute for human labor were the proposed solutions.

O10 - Managing ecosystem services in rice landscapes: contrasting effects of structurally diverse habitats on egg parasitoids and pollinators

Catrin Westphal[1], Christina Sann[2], Annika L. Hass[1], Stefan Vidal[2], Finbarr G. Horgan[3], Teja Tscharntke[1], Kong L. Heong[4], Josef Settele[5,6]

[1]Agroecology, Georg-August-Universität, Göttingen, DE
[2]Agricultural Entomology , Georg-August-Universität, Göttingen, DE
[3]Crop and Environmental Sciences Division, International Rice Research Institute (IRRI), Los Baños, PH
[4]Centre for Agricultural Bio Sciences International (CABI), Serdang, MY
[5]Helmholtz-Centre for Environmental Research – UFZ, Department of Community Ecology, Halle, DE
[6]iDiv, German Centre for Integrative Biodiversity Research, Leipzig, DE

Habitat management needs comprehensive perspectives, considering multiple ecosystem services at local and landscape scales. Hymenoptera can provide different kinds of ecosystem services like pollination and biological control that are not only essential for the stability of ecosystems but also for the benefit of humans. Currently, ecological engineering by habitat management and participatory training programmes and mass media entertainment-education programmes are developed to counteract the ongoing intensification of rice production in Southeast Asia, and these schemes often suggest the implementation of additional flower rich habitats, since they aesthetically enrich production landscapes and provide supplementary food resources and shelter for natural enemies and pollinators. Yet, the effects of structurally complex and flower rich habitats for both natural enemies and pollinators have not been studied in rice production landscapes. We hypothesise that both natural enemies (specifically egg parasitoids) and pollinators benefit from additional floral resources and suitable habitats for nesting in rice production landscapes.

We selected eight study areas in Luzon, Philippines, each comprising three study sites: 1. rice field embedded in rice monoculture, 2. rice field embedded in structurally diverse surroundings, and 3. agroforest.

In contrast to our hypothesis, our results indicate that pollinators and natural enemies respond differently to flower rich and structurally diverse habitats. Species richness and abundance of pollinators was highest in structurally diverse rice fields and agroforests, whereas egg parasitoids of plant- and leafhoppers (major rice pests) did not benefit from additional resources and retreat areas in structurally diverse rice fields or agroforests.

To manage multiple services in rice production landscapes, specific approaches are needed to enhance both pest regulation and pollination services.

O11 - Do spiders in Philippine rice fields prefer aquatic over terrestrial prey?

Nico Radermacher[1], Stefan Scheu[1]

[1]Georg-August-Universität, Animal Ecology, Göttingen, DE, nraderm@gwdg.de

Within the framework of the LEGATO project ("Land-use intensity and ecological engineering-assessment tools for risks and opportunities in irrigated rice based production systems") we investigate the food web of irrigated rice field production systems on the Philippines. By analyzing natural variations in carbon and nitrogen stable isotope ratios we studied the role of spiders as generalist predators as well as planthoppers (Cicadellidae and Delphacidae) and dipteran larvae (Ceratopogonidae and Chironomidae) as their terrestrial and aquatic prey resources respectively. Field work was conducted using suction sampling and sweep nettingearly, intermediate and late during the rainy season in 2012. We hypothesized that aquatic detritivores and herbivores contribute significantly to the functioning of rice field food webs thereby affecting the role of generalist predators for controlling insect pest species of rice. First results of carbon stable isotope analysis indicate that carbon accumulated by spiders is mostly derived by dipterans suggesting that spiders prefer detritivorous mosquitos over herbivorous planthoppers during the whole cropping season. Results suggest that a majority of the spider diet components is comprised by dipterans which, as abundantly available prey, can sustain generalist predators during the cropping season and thereby promote their impact on planthoppers and rice insect pest control. To describe the amounts of different prey to spider nutrition precisely and to find out about the functioning of the rice field food web further research is necessary and ongoing.

O12 - Hitching a ride on a mountain bike - potential seed dispersal through recreational activities

Fabio Weiss[1], Tyler Brummer[2], Gesine Pufal[1]

[1]University of Freiburg, Freiburg, DE
[2]Lincoln University, Lincoln, NZ

Seed dispersal enables plants to colonize new habitats but if seeds are dispersed in a non-native range, they might become invasive and pose a potential threat to native ecosystems and biodiversity. Most non-native plants are unintentionally dispersed by different means of transportation, i.e. ships, trains or cars. Recreational activities such as boating or hiking might also aid non-native seeds in reaching areas of sensitive conservation status.
Mountain biking is increasing in popularity with riders frequenting different areas and ecosystems and also accessing areas usually not reached by hiking trails. They could therefore transport seeds between different ecosystems and disperse non-native seeds into vulnerable areas.

We tested the attachment of seeds with different traits under varying environmental conditions to different mountain bike parts. Specifically, we assessed dispersal distances of seeds attached to tyres to make assumptions about the potential of mountain bikes as dispersal vector for non-native seeds.

We spread coloured seeds of five species differing in weight, shape and size in a specified area with a density of 1.17 seeds/cm2. We crossed this area with a mountain bike in wet and semi-wet conditions and seeds attached to tyres were counted at distances of 0 to 500 m after the initial run through the seeds.
Depending on the seed species, almost 40% of the exposed seeds attached to the bike. More seeds attached in semi-wet conditions and dispersed over longer distances. Flat or needle-like seeds attached more often to the tyres compared to round seeds. Between 50 and 70% of seeds were dispersed within the first five meters but single seeds reached distances of 100 and 500 m in wet and semi-wet conditions, respectively.
Moreover, seeds that attached to other parts of the bike, i.e. the saddle or frame, were found after distances of more than five kilometres.
We demonstrate that mountain bikes can serve as dispersal vectors for different seed species. Especially when mountain bike riders use different areas, they might unintentionally transport seeds of non-native plants into vulnerable areas. Especially in areas of sensitive conservation status, a considerate use of mountain bike trails and the responsible handling of the equipment, i.e. cleaning of the bike between uses, should be advocated.

P1 - The influence of environmental perception and media coverage upon pro-environmental engagement - a case study by the horse chestnut leafminer

Rebecca Rogers[1], Werner Heitland[1], Anja Uretschläger[2], Cornelia Wallner[2], Bernhard Goodwin[2], Hans-Bernd Brosius[2], Wolfgang W. Weisser[1]

[1]Technische Universität München, Freising, DE, rebecca.rogers@tum.de
[2]Ludwig-Maximilians-Universität München, München, DE

To meet the needs of current and further generations, public understanding of socio-environmental problems and support for management strategies need to be raised. As outcomes of human actions and natural phenomena are showing strong impacts, it is essential that natural and social science will work interdisciplinary in order to identify variables that facilitate communication from scientists to the public to allow for more effective socio-environmental management. Within a 2x3 experimental design we investigated (1) the importance of the publics perception of environmental changes and (2) the ideal level of complexity and quality of information in media for understanding of scientific information and the resulting actions by the citizens. As model case we used the invasive horse chestnut leafminer *Cameraria ohridella* Deschka & Dimic (Lepidoptera: Gracillariidae). The leafminer causes a distinctive pattern of damage to white flowering horse chestnut trees (*Aesculus hippocastanum*), which is clearly observable for citizens. Additionally, many pro-environmental behaviors can be undertakenby anyone willing to restrict the degree of infestation on trees in their neighborhood. We set up a quantitative survey in two waves (N_1=479; N_2=295) in 12 German regions in 2014, showing either high or low infestation level. Randomly chosen people (aged between 18 and

70) were assigned to one of three newspaper articles (tabloid, quality-journalistic, popular-scientific) differing in their journalistic representation, complexity and fragility of content with respect to the chestnut leafminer. The articles were incorporated as an experimental stimulus within the online questionnaire, which included questions based on valid scales such as the degree of environmental change perception, subjective risk perception and individual change of behavior. Our results indicate that (1) the perception of an environmental change is a highly important factor contributing to risk perception and adaption of environmental behavior. (2) We could show that media influence is limited, but that the article with medium level of complexity, quality and fragility (quality-journalistic article) showed the greatest effects on change of risk perception and behavioral adaption compared to the tabloid and the popular-scientific article.

P2 - The Era of Anthropocene and cultural environmental adaptions

Ani Bajrami[1]

[1]Department of Biology, University of Tirana, Tirana, AL, ani.bajrami@fshn.edu.al

Ecology as a scientific discipline tends to explain the interactions and the relations between animals and their natural habitat. Environmental anthropology is focused on the examinations of the relationships between humans and their environment and its origin dates back to Steward's concept of cultural ecology and Roy A. Rappaport ecological anthropology. Additionally, in order to understand human development, the entire ecological system in which growth occurs needs to be taken into account (Bronfenbrenner 2005).The purpose of this paper is to explain the formation of the so called artificial environments created in the course of human cultural evolution. The ability to adapt biologically and culturally is a distinct human feature (Boyd and Richerson 2005) which set human society apart from every other form of social organization. The cultural evolution of human societies is a process involving cultural adaptions and the rise of new cultural features in relation to the efficient use of the environment and the result is the formation of the "artificial environment". This different environment is an technological environment created and used by humans so to assure their future evolution, both as biological species and cultural agents.

Keywords: anthropocene, human cultural evolution, cultural environmental adaptions, artificial environments

END OF SESSION 12

Session 13 - Land use, biodiversity and ecosystem services

CHAIR: PROF. DR. NICO BLÜTHGEN

O1 - Plant diversity and season strongly affect predation rates in experimental grasslands

Anne Ebeling[1], Lionel R. Hertzog[2], Sebastian M. Meyer[2], Wolfgang W. Weisser[2]

[1]University Jena, Jena, DE, anne.ebeling@uni-jena.de
[2]Technische Universität München, Munich, DE

After decades of biodiversity research, it is concurrent knowledge that plant diversity effects propagate through trophic levels. Multi-trophic analyses in grasslands revealed that consumer diversity is positively affected by plant species richness and biomass. Predation is one of the ecosystem functions mediated by consumer species, having important effects on their prey and indirectly on plant communities. However, no studies so far linked producer diversity to predation rates in terrestrial experimental system.

Here we tested the effect of experimentally manipulated plant diversity on predation rates in central Germany. We measured predation rates using three different prey organisms, namely aphids, mealworm larvae and plastiline dummies. We found strong positive effects of plant species richness and plant community productivity on predation rates of aphids and caterpillar dummies. Generally, there were significantly higher predation rates in early than in late summer. Predation of mealworms were negatively affected by plant species richness in early summer, but the opposite pattern occurred in late summer. Our results indicate that changes in plant diversity in grasslands lead to changes in ecosystem functioning due to the strong link between plants and consumers. From the strong seasonal differences in predation rates, we can assume shifts in the predator communities during the vegetation period. Understanding the mechanism linking plant diversity to consumer diversity and the functions they mediate will improve our knowledge about how ecosystem will respond to biodiversity loss.

O2 - Interlinkages between biodiversity, ecosystem services and socio-economics in vineyards (BiodivERsA project VineDivers)

Johann G. Zaller[1], Silvia Winter[2], Peter Strauss[3], Thomas Bauer[3], Pascal Querner[1], Jacob Buchholz[1], Monika Kriechbaum[2], Bärbel Pachinger[2], Kratschmer Sophie[2], José Gómez[4], Mercedes Campos[4], Blanca Landa[4], Daniel Paredes[5], Daniela Popescu[6], Maria Comsa[6], Maria L. Iliescu[6], Liliana L. Tomoiaga[6], Claudiu-Ioan Bunea[7], Adela Hoble[7], Liviu A. Marghitas[7], Teodor Rusu[7], Ángel Lora[8], Gema Guzmán[8], Holger Bergmann[9], Martin Potthoff[9], Rebekka Schütte[9], Daniel Cluzeau[10], Françoise Burel[1], Annegret Nicolai[10], Muriel Guernion[10], Vincent Jung[10]

[1]Institute of Zoology, University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, AT, johann.zaller@boku.ac.at
[2]Institute of Integrative Nature Conservation Research, University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, AT
[3]Institute for Land and Water Management Research, Austrian Federal Agency for Water Management, Petzenkirchen, AT
[4]Spanish National Research Council (CSIC), Instituto de Agricultura Sostenible, Cordoba, ES
[5]Spanish National Research Council (CSIC), Department of Crop Protection, Granada, ES
[6]Research Station for Viticulture and Enology Blaj, Blaj, RO
[7]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca (UASMV Cluj-Napoca), Faculty of Horticulture, Department of Horticulture and Landscaping, Cluj-Napoca, RO
[8]University of Córdoba, Department of Forestry Engineering, Córdoba, ES
[9]University of Göttingen, Department for Agricultural Economics and Rural Development, Göttingen, DE
[10]University Rennes 1, UMR CNRS EcoBio, Paimpont, FR

Essential ecosystem services provided by viticultural landscapes result from diverse communities of above- and belowground organisms and their interactions. For centuries traditional viticulture was part of a multifunctional agricultural system including low-input grasslands and fruit trees resulting in a high functional biodiversity. However, in the last decades intensification and mechanisation of vineyard management caused a separation of production and conservation areas. As a result of management intensification including frequent tilling and/or use of pesticides several ecosystem services are affected leading to high rates of soil erosion, degradation of soil structure and fertility, contamination of groundwater and high levels of agricultural inputs. In this transdisciplinary project we will examine to what extent differently intensive managed vineyards affect the activity and diversity of soil biota (e.g. earthworms, collembola, soil microorganisms) and how this feeds back on aboveground biodiversity (e.g. weeds, pollinators). We will also investigate ecosystem services associated with soil faunal activity and biodiversity such as soil structure, the formation of stable soil aggregates, water infiltration, soil erosion as well as grape quality. These effects will become increasingly important as more extreme precipitation events are predicted with climate change. The socio-economic part of the project will investigate the role of diversely structured, species-rich viticultural landscapes as a cultural heritage providing aesthetic values for human well-being and recreation. The project objectives will be analysed at plot, field (vine-

yard) and landscape scales in vineyards located in Spain, France, Romania and Austria. A detailed engagement and dissemination plan for stakeholder at the different governance levels will accompany scientific research and will contribute to the implementation of best-practice recommendations for policy and farmers.

03 - Does land use affect litter decomposition?

Marco Guerreiro[1], Derek Peršoh[1]

[1]Department of Geobotany, Faculty of Biology and Biotechnology, Ruhr-Universität Bochum, Bochum, DE

Decomposition of plant litter is a key process in nutrient cycling, which is predominantly accomplished by fungi in temperate forest ecosystems. The fungal decomposer communities are species-rich and strongly structured in space and time. Geographic location, climate, plant communities, chemistry of litter and soil are just a few factors known to shape the taxonomically diverse communities. By contrast, recent studies on enzymes involved in decomposition revealed a high degree of functional redundancy among the communities. We therefore hypothesize that forest management has an impact on the composition of the decomposer communities in beech forests, but not on the decomposition processes themselves.

To test this hypothesis, we benefited from the design of the Exploratories for functional biodiversity research (DFG Priority Programme 1374). Samples of one-year-old litter were collected from beech forests in the north (Schorfheide-Chorin), centre (Hainich-Dün) and south (Schwäbische Alb) of Germany. The forests were either unmanaged or managed as age-class and selection cut forests. Using Illumina Next-Generation Sequencing (NGS), we sequenced DNA- and RNA-derived fungal taxonomic barcoding markers. The major focus was laid, however, on metatranscriptome (gene expression profile) analyses. The whole eukaryotic mRNA was sequenced in 18 samples to assess functional diversity of the litter decomposing communities. We obtained >100 million mRNA sequences, which were assembled to >1.2 million contigs, representing transcribed genes. Among the expressed genes, >50 encoded for exoenzymes involved in litter decomposition.

Taxonomic composition of the decomposer communities and their expression profiles of functional genes will be discussed against the geographic, climatic and land use gradients represented in the Biodiversity Exploratories. A special focus will be laid on the phylogenetic diversity of the taxa actively involved in key processes of decomposition, such as the ligninolytic, cellulolytic and pectinolytic parts of the community.

O4 - Different effects of mineral and organic fertilization on activity and composition of soil microbial communities in a long-term experiment

Davide Francioli[1], Elke Schulz[1], Guillaume Lentendu[1], Tesfaye Wubet[1,3], François Buscot[1,2,3], Thomas Reitz[1,3]

[1]UFZ-Helmholtz Centre for Environmental Research, Department of Soil Ecology, Halle Saale, DE, davide.francioli@ufz.de
[2]University of Leipzig, Institute of Biology, Leipzig, DE
[3]German Centre for Integrative Biodiversity Research (iDiv), Leipzig, DE

Agricultural practices often take place without considering their long-term effect on ecosystem biodiversity. Studies in agricultural long-term experiments allow enlightening the effects of different land management on the ability of cropping systems not only to ensure productivity but also to maintain ecosystem functions and services, in particular quality and biodiversity of soils. In this study we addressed the question how long-term organic and mineral fertilization along with the accompanying nutrient inputs influence the microbial community structure and activity in soils. We used soil samples from a centenary long-term experiment (Bad Lauchstädt, Germany) with four different fertilization treatments (no fertilization, mineral fertilization, organic fertilization, combined mineral and organic fertilization). The effect of long-term nutrient input (113 years) on soil was investigated using a multidisciplinary approach that involved the survey of physico-chemical parameters, soil microbial biomass, bacterial and fungal community structure (determined by high-throughput amplicon pyrosequencing) and microbial activity (determined by enzyme assays) across the four land management practices. Organic fertilization increased considerably the soil nutrient availability compared with the unfertilized and mineral fertilized treatments, and this is reflected by a higher concentration of soil microbial biomass carbon in the treatments receiving manure. In contrast, the activity of microbial exoenzymes in soil, which increased in any fertilized treatments, was significantly enhanced in the mineral fertilized plots considering that the treatments receiving manure showed a notable higher microbial biomass than the mineral one. Significant differences were also observed in the community composition of soil microorganisms since each land management surveyed appeared to harbor a distinct microbial community. Moreover, our results reveal that the fertilization regime exerts an influence on certain beneficial or detrimental microbial taxa that appeared closely associated with particular land management practices. This suggests that a multidisciplinary approach could representa valid methodology to survey the effect of specific farming strategies on the soil ecosystem.

O5 - Species diversity governs the spread of pesticide resistance

Jeremias Becker[1,2], Matthias Liess[1,2]

[1]Dept. System Ecotoxicology, Helmholtz Centre for Environmental Research GmbH - UFZ,

Leipzig, DE, jeremias.becker@ufz.de
[2]Department of Ecosystem Analysis, Institute for Environmental Research, RWTH — Aachen University, Aachen, DE, jeremias.becker@ufz.de

Agricultural pests and pathogen vectors have rapidly evolved high levels of pesticide resistance. In contrast, most aquatic non-target species have developed only slightly increased resistance to pesticides from agricultural run-off. This has been demonstrated for limnic macroinvertebrates from central Germany. We hypothesized that the contrasting potential for genetic adaptation to toxicants results from different competitive conditions in both groups.

Resistant individuals typically experience fitness costs in a non-toxic environment. In contrast, after a pulse exposure to pesticides the surviving susceptible individuals experience fitness costs. Additional environmental stressors increase such fitness costs and foster both the spread of pesticide resistance and the genetic recovery of a resistant population when pesticide treatments have stopped.

As demonstrated in the mosquito *Culex quinquefasciatus*, interphenotypic competition between susceptible and resistant individuals is a particularly important driver of microevolution. This is because the adapted phenotype outcompetes the non-adapted phenotype. When interphenotypic competition was reduced through predation or replaced by interspecific competition with the water flea *Daphnia magna*, the fitness contrast between susceptible and resistant mosquito larvae decreased and microevolution was delayed.

We conclude that in diverse aquatic communities, species interactions can limit the potential for the spread of pesticide resistance. In contrast, high levels of intraspecific competition foster the spread of resistance in simplified communities such as monocultures and mosquito breeding sites. Strategies for an integrated pest control should recognize this ecosystem service of species diversity for resistance management.

O6 - On the difficulty of generalization in land use-biodiversity patterns - the odd case of Tibetan Kobresia pygmaea pastures

Elke Seeber[1], Yun Wang[1], Roland Schultz[1], Maika Holzapfel[1], Georg Miehe[1], Isabell Hensen[1], Jianquan Liu[1], Yongping Yang[1], Karsten Wesche[1]

[1]Senckenberg Museum of Natural History, Görlitz, DE, karsten.wesche@senckenberg.de

Tibet hosts the world’s largest alpine ecosystems and some of the most extensive rangelands. Grazing degradation is commonly described in the region. Published estimates of degradation extent, however, differ widely due to lack of comparative studies and generalizing results from single sites and general theory. Here, we present data from a study covering 18 sites representative of the entire Tibetan plateau, supplemented by a regional scale elevational transect study, and finally data from a carefully selected site representative for the alpine core region of Tibetan rangelands.

In spite of widely held assumptions, comparisons of heavily and lightly grazed sites across the plateau yielded ambiguous evidence for degradation threat. We tested a broad range of indicators and found limited congruence among indicator responses to both grazing and abiotic conditions. Most indicators were not affected by differences in grazing intensity, and even those sensitive displayed only modest responses.

We assessed community-level species diversity as well genetic and clonal diversity of the overwhelmingly dominant sedge *Kobresia pygmaea* along a ~1500 m elevational gradient in eastern Tibet. In spite of harsh climate and intense grazing, genetic diversity of *K. pygmaea* populations was high, facilitated by high clonal diversity and genet longevity. Moreover, genetic and reproductive traits showed an unusual inverse unimodal response to increasing elevation.

Exclosure experiments at the alpine core site at 4450 m asl. supported observations of modest grazing effects. Species diversity hardly responded at all, while reproduction of the dominant *K. pygmaea* was reduced under grazing exclusion. Instead, co-limitation by soil nitrogen and phosphorus had strong effects, while responses to inter-annual climate variability were again limited. Taken together, our results demonstrate that site and species-specific characteristics must be considered to devise appropriate management strategies.

O7 - Drivers of the biological control service providers in mid-field forest fragments

Rauno Kalda[1], Taavi Paal[1], Jaan Liira[1]

[1]University of Tartu, Tartu, EE

Mid-field forest patches are sources of ecosystem service provision in agricultural landscape. We studied the abundance of insectivorous predator guilds, which can act as service providers of biological control. We hypothesized that the various effects of woodland history, stand habitat quality, and landscape structure drive the abundance of these guilds, but the set of drivers depends on groups‘ mobility and foraging specificity.

The survey was carried out in two 5x5 km agricultural landscape windows in central Estonia, in boundaries and interiors of boreonemoral forest fragments. We addressed four insects guilds: rove beetles (*Staphylinidae*), black snail beetle (*Phosphuga atrata*), small and large body size carabids (*Carabidae*); and two foraging guilds of bats: woodland specialist and generalist.

We found that low mobility functional groups depended on the historical continuity of a forest patch, while mobile groups were mostly affected by present structure and composition of a stand and its surrounding landscape. Large carabids showed the suppression effect by agricultural matrix. Bats illustrated the effect foraging specificity, as SRE-bats showed significant reaction on stand structure and compositional properties, while LRE-bats reacted on woodland edge conditions and landscape. The shelter and roosting sites were important for several groups in a form of lying dead wood and herb layer for ground dwellers, and the presence of buildings in the neighbourhood for bats.

The association of a environmental driver package and ecological profile of functional guilds emphasizes the importance of spatio-temporal quality of habitat patches and the use of sustainable methods in crop fields. A complex community of biocontrol agents is particularly supported by those mid-field forest patches, which have historical continuity, are structurally diverse and sustainably managed, but have spatial integration with other micro- and macrostructures in the surrounding landscape. The diversifying of ground layer conditions, such as decaying logs and sections of shady herb layer, could be supportive also in open field margins.

O8 - Natura 2000 habitat conservation status mapping by airborne laser scanning

András Zlinszky[4], Balázs Deák[3], Adam Kania[5], Anke Schroiff[6], László Bekő[2], Norbert Pfeifer[7]

[2]Research Institute of Remote Sensing and Rural Development, Károly Róbert College, Gyöngyös, HU
[3]MTA-DE Biodiversity and Ecosystem Services Research Group, Debrecen, HU
[4]Balaton Limnological Institute, Centre for Ecological Research, Hungarian Academy of Sciences, Tihany, HU, zlinszky.andras@okologia.mta.hu
[5]ATMOTERM S.A., Opole, PL
[6]YggdrasilDiemer, Berlin, DE
[7]Research Groups Photogrammetry and Remote Sensing, Department of Geodesy and Geoinformation, Vienna University of Technology, Vienna, AT

Within the context of the Natura 2000 programme, vegetation map sand habitat quality parameters have been successfully derived from various remote sensors. Nevertheless, since conservation status as defined by the Habitats Directive is a complex parameter composed as a weighted sum of many different variables, it was so far not possible to automatically derive it from remote sensed data.

In this study, we aimed to fill this gap by automatically mapping all conservation status variables in an alkali open landscape required by the Hungarian national Natura 2000 monitoring guidelines.

We used high-resolution full-waveform airborne laser scanning (ALS). ALS data were collected data during leaf-off and vegetation period. Radiometric calibration based on in-situ spectrometry and a wide range of field references including 20 full conservation status assessments allowed optimal exploitation of the information within the point cloud. We built our own classification software based on random forest machine learning and fuzzy class theory, and created maps of vegetation categories and conservation status relevant variables with a spatial resolution of

0.5 meters. Selected map products were then used as proxies of the parameters required by the assessment scheme, and their weighted sum generated by a GIS script exactly as prescribed for final conservation status categorization.

We found that the class probabilities predicted by fuzzy classification for various habitat types correlated well with naturalness and species composition. However, species density was difficult to quantify from the point cloud. The difference in leaf-on and leaf-off reflectance proved to be a good proxy for overgrazing or undergrazing, though alkali meadows and shortgrass alkali steppes required different threshold values. Shrub and weed encroachment together with roads and tracks were well detected by the algorithm. 80% of the validation plots were identified correctly, and since we followed the local Natura 2000 monitoring guidelines, these results are directly comparable to field assessment.

While adaptation to other sites remains to be tested, our results show that operational use of remote sensing of Natura 2000 assessment is feasible. This contribution was sponsored by “TÁMOP-4.2.2.D-15/1/ KONV-2015-0010”.

O9 - Land use and the portfolio effect: community stability of plants, birds, bats and arthropods

Nico Blüthgen[1], Nadja K. Simons[2], Kirsten Jung[3], Daniel Prati Daniel Prati[4], Swen C. Renner[5], Steffen Boch[4], Norbert Hölzel[6], Valentin H. Klaus[6], Till Kleinebecker[6], Marco Tschapka[3], Wolfgang W. Weisser[2], Martin M. Gossner[2]

[1]Technische Universität Darmstadt, Darmstadt, DE, bluethgen@bio.tu-darmstadt.de
[2]Technische Universität München, München, DE
[3]University of Ulm, Ulm, DE
[4]University of Bern, Bern, CH
[5]University of Natural Resources and Life Sciences, Vienna, AT
[6]University of Münster, Münster, DE

Long-term stability of ecosystem functions provided by species communities is fundamental for biodiversity conservation and represents a main goal for sustainable management of natural resources. Since species that contribute to the same ecosystem function might respond differently to environmental drivers, community stability is a precondition for functional stability in ecosystems. Community stability can be achieved by higher species diversity (portfolio effect), higher asynchrony across species (insurance hypothesis) and higher abundance within the community. The relative importance of these mechanisms in different taxonomic groups and how they are affected by real-world drivers of diversity is unknown for terrestrial ecosystems. Here we show that conversion of forests to grassland and land-use intensification imperil community stability via reduced diversity, asynchrony, and total abundance of individuals in a comparison of plants, birds, bats and arthropods with a total of 2734 species in 300 sites. We found that community stability in animals was up to 2.5–fold lower in grasslands than in forests. Within forests and grasslands, land-use intensity did not directly decrease community stability for most taxa, but destabilized communities indirectly via different routes. Overall, asynchrony had the strongest stabilizing effect. Our results highlight that diversity alone insufficiently predicts variation in community stability across taxa, habitats and land-use gradients, whereas asynchrony is particularly important for long-term stabilization of ecosystem functions and the implementation of sustainable management.

O10 - Even-aged management does not decrease biodiversity in European beech forests

Peter Schall[1], Martin Goßner[2], Christian Ammer[1]

[1]Georg-August University Göttingen, Göttingen, DE, peter.schall@forst.uni-goettingen.de
[2]Technische Universität München, Freising, DE

Managed beech forests are assumed to harbour lower biodiversity than unmanaged reference forests. The grain of management operations characterizes forest management systems (FMS), whereby even-aged (grain = stand) and uneven-aged (grain = single tree) FMS represent gradient edges. As small-scale forest structural heterogeneity decreases with grain size, it is widely presumed, that beta- and gamma-diversity are lowest under the even-aged FMS, while beta species loss component should outnumber beta species turnover component. This is why fine-grained 'close-to-nature' forest management is currently favoured in the temperate zone.

However, evidence on assumed effects of FMS on biodiversity is fragmentary, i.e. in European beech forests. Therefore we sampled species diversity across kingdoms of bacteria, fungi, plants and animal in even-aged, uneven-aged and unmanaged forests within the Biodiversity Exploratories framework.

We found that diversity of bacteria, fungi, plants and animals is higher or equal in even-aged forests than in unmanaged or uneven-aged forests, even for forest specialists. Gamma-diversity was higher for 8 of the 15 taxonomic groups investigated under even-aged FMS compared to unmanaged forests (up to 72%) as well as to uneven-aged FMS (up to 77%), while 7 groups showed no difference, respectively. Beta-diversity contributed more to gamma-diversity in even-aged than in unmanaged forests for 9 taxonomic groups, while one group responded contrarily. Beta turnover component was not lower under even-aged FMS than in unmanaged and uneven-aged forests for most taxonomic groups. Forest specialists showed concordant patterns for gamma- and beta-diversity.

Our results demonstrate that the pervasive assumption suggesting adverse effects of forest management on biodiversity deserves revision. Moreover, abandoning or decreasing the grain of forest management may have strong unwanted effects on biodiversity. Based on our results promoting spatio-temporal variation of forest management instead of uniformity seems to favour biodiversity.

This suggests that evidence based biodiversity conservation/forest management policies in temperate forests are urgently needed. Good practice guidelines that are implemented today may not maintain biodiversity and should be re-evaluated.

O11 - Enriching plant diversity in temperate grasslands: Lessons learned from a large-scale seeding and disturbance experiment

Valentin Klaus[1], Daniel Prati[2], Till Kleinebecker[1], Deborah Schäfer[2], Barbara Schmitt[2], Markus Fischer[2], Norbert Hölzel[1]

[1]Universität Münster, Münster, DE, v.klaus@uni-muenster.de
[2]Universität Bern, Bern, CH

Grassland biodiversity still drastically declines in many countries in the temperate zone. Intensive land management and the use of commercial seed mixtures generate species-poor, monotonous grasslands. This reduced plant diversity is not only a biodiversity concern, but it may also restrict certain ecosystem services. During the recent past, the management intensity of several grasslands has been significantly reduced either for economical or ecological reasons. However, due to seed and dispersal limitation, such nowadays low-intensively used grasslands remain species-poor over decades. Nevertheless, these grasslands hold a vast but untapped biodiversity potential.

Here, we present a large-scale seeding and disturbance experiment in agricultural grasslands in Germany. We test the application of topsoil disturbance and seed addition using a regionally produced mixture of native plants and assessed their effects on plant diversity and ecosystem functioning. Study plots are arranged along a gradient of land-use intensity to gather information on the influence of grassland management on the success of diversity enrichment. As first results indicate, our treatments were effective to increase plant diversity significantly, although difference among study regions was obvious. We thus have to stress the relevance of seed and dispersal limitation for grassland vegetation and underline the option to significantly enrich plant communities using locally produced seed mixtures. Additionally, results hint at a possibly positive effect of enriched plant diversity for grassland productivity, giving a promising example of a win-win situation for nature conservation and agricultural grassland use.

O12 - Interrelation of plant functional diversity, nutrient stoichiometry and land use intensity

Verena Busch[1], Markus Fischer[2], Fabrice Grassein[2], Norbert Hölzel[1], Valentin Klaus[1], Daniel Prati[2], Till Kleinebecker[1]

[1]Institute of Landscape Ecology, University of Münster, Münster, DE, buschv@uni-muenster.de
[2]Institute of Plant Sciences, University of Berne, Berne, CH

Land use intensification and change are considered the most important threats affecting biodiversity. Hence, land use may be seen as the major disturbance factor in grasslands directly affecting plant diversity and vegetation composition. Furthermore, land use also impacts nutrient stoichiometry in soil and plant biomass. Functional diversity as one component of plant diversity has rarely been taken into account in relation to nutrient stoichiometry, although it has been shown that the richness of functional traits strongly determines ecosystem functioning and stability. Furthermore, identifying changes in the functional composition of a plant community is crucial to understand underlying mechanisms of biodiversity changes. Our research aims at evaluating the impact of land use and nutrient stoichiometry on plant functional diversity. Therefore, we assessed plant species richness and productivity and measured nutrient concentrations in aboveground biomass in 150 agricultural grasslands in three regions in Germany during a time period of six years. Additionally, functional trait information regarding reproduction, phenology, leaf economy and competition ability was used to calculate community weighted means (CWM) and functional diversity (FD).
First results showed distinct relationships between functional trait diversity, land use and biomass nutrient concentrations, even though specific relationships vary considerably depending on the respective trait. Variability of reproductive and competition ability-related traits such as vegetation height showed strong responses to land use, especially grazing and fertilization intensity. Flowering onset and seed mass were negatively influenced by increased fertilization, whereas a higher grazing intensity favors species with reduced seed mass. Furthermore, both CWM and FD of all plant traits are strongly associated with nitrogen and phosphorus concentrations in biomass, which are known to increase with increasing fertilization. However, our analyses revealed that the impact of land use on functional diversity may be mostly indirect, mediated by decreasing plant diversity in the course of intensive management. Our study shows that in order to improve the understanding and prediction of diversity patterns and ecological changes as a result of anthropogenic disturbance, an integrative approach is needed, considering functional composition of the vegetation, stoichiometric regulation and management information.

O13 - Slow crawling gastropods prevent rapid succession and maintain diversity in epiphytic cryptogam communities

Steffen Boch[1], Daniel Prati[1], Santiago Soliveres[1], Markus Fischer[1]

[1]Institute of Plant Sciences, University of Bern, Bern, CH

Herbivore effects on species richness and community successional trends are well-understood in plants but much less in other important organisms, such as cryptogams (lichens, fungi, algae and bryophytes). Cryptogams occur in essentially all habitats and are an important food resource of various animals. Based on the results from plant studies, we would also expect a reduction of competitive interactions among cryptogams and the creation of colonizable gaps with grazing. As long-term herbivore exclusion experiments from cryptogam communities are missing, we conducted a gastropod exclusion experiment on trees in the Schwäbische Alb, Germany. We estimated the abundance and grazing damage of all lichen, bryophyte and bark colonizing fungus species as well as the abundance of free living green algae. We recorded the diversity and cover of all cryptogams across 6 years. We found gastropods to be important herbivores of epiphytic cryptogams, preventing rapid successional changes by the reduction of competitive interactions among the different kingdoms. In our controls, gastropod grazing regulated algae and fungus growth and thereby maintained, although also strongly grazed (about 30% and 5 % of lichen area grazed on European beech and Norway spruce, respectively), the diversity and high cover of lichens. In our exclusion treatment, the release from gastropod grazing caused rapid succession because algae and fungi overgrew lichens, resulting in an overall reduced diversity compared to the control treatment. Herbivory effects were more pronounced on European beech than on Norway spruce, and bryophytes were generally not affected by gastropod grazing. We conclude that grazing by gastropods prevents rapid successional changes in cryptogam communities, which were commonly thought to be slow growing. Thus, gastropods are important to maintain cryptogam diversity and composition by the reduction of competitive interactions.

O14 - On the dimensionality of ecosystem multifunctionality

Santiago Soliveres[1], Fons van der Plas[1], Pete Manning[1], Markus Fischer[1], Eric Allan[1]

[1]University of Bern, Bern, CH, santiago.soliveres@ips.unibe,ch

Research on the factors driving the ability of ecosystems to maintain multiple functions and services simultaneously (multifunctionality) has exponentially gained momentum during the last decade. However, our ability to evaluate ecosystem multifunctionality is hindered by limited budgets or scientific expertise, both limiting the number and variety of functions measured in research projects. Thus, how reliable and comprehensive are the multifunctionality indicators across different studies remains poorly understood. Here, we use an extensive dataset including 13 ecosystem functions measured across 150 temperate agricultural grasslands to i) search for “indicator functions” (those related to other functions and services), ii) assess how land-use intensification affect the relationship between different functions and the dimensionality of ecosystem multifunctionality, and iii) quantify how many functions to include, and how correlated they can be, to provide a reliable multifunctionality index. Our results show that P retention and mycorrhizal biomass are best correlated with multifunctionality and to most separate functions, respectively, and thus could work as “indicator functions” paralleling indicator taxa in biodiversity research. We also found that land-use intensification strengthen correlations between functions, particularly between those related to nutrient cycling and pest control, but reduced the relationship between the different ecosystem services and multifunctionality. Another consequence of land-use intensification was to reduce the dimensionality of ecosystem multifunctionality from 6 to 4 axes, being those dominated by plant productivity rather than by regulating and cultural services in high vs. low land-use intensity. Lastly, to provide a more reliable multifunctionality index, we found that a high (>10) number of functions is more important than the correlation between them, although this may depend on the index used.

O15 - Stronger effects of dung beetle biomass than functional diversity on dung removal in temperate habitats

Jörn Buse[1], Martin H. Entling[1]

[1]University Koblenz-Landau, Landau, DE, busej@uni-landau.de

Ecosystem processes depend on the biomass of the involved organisms, but their functional diversity may play an additional role. In particular, the exclusion of key functional groups through habitat disturbance may lead to the breakdown of ecosystem functions. Dung removal is an important process contributing to nutrient cycling and thus productivity in grazed ecosystems. We studied the role of different functional groups of dung beetles for dung removal in different habitats. Dung removal was reduced by almost 40% in grassland compared to adjacent forest and forest gaps. This pattern could be explained by changing proportions of functional groups of dung beetles between habitats, with reduced abundance of large tunnellers in grassland. Total biomass of tunneller species was largely determined by abundance of large-bodied species and explained between 75% (summer) and 89% (autumn) of the variation in dung removal. Unlike in tropical habitats, species diversity and the number of functional groups did not or inly weakly explain the observed pattern of dung removal. We conclude that dung removal is habitat-specific and large tunnellers play a disproportionate role for this important ecosystem function in temperate habitats.

O16 - The distribution of endangered saproxylic beetles in Schleswig-Holstein (Northern Germany) as influenced by historic land use and land tenure patterns

Andreas Mölder[1], Stephan Gürlich[2], Falko Engel[1]

[1]Northwest German Forest Research Station, Section Forest Conservation, Göttingen, DE, andreas.moelder@nw-fva.de
[2]Büro für koleopterologische Fachgutachten, Buchholz, DE

The present distribution patterns of plant and animal species in the cultural landscape are often related to land-use history. This is particularly true for saproxylic beetles with low dispersal abilities which are depending on a continuous tradition of overmature trees and dead wood. We analysed the distribution patterns of endangered saproxylic beetles in the Federal State of Schleswig-Holstein (Northern

Germany) and searched for dependencies on historic land use and land tenure patterns. In doing so, we compared the occurrences of saproxylic beetles in the Schleswig-Holstein state forests with those in private and corporation forests, since this land tenure pattern has been nearly stable for about 200 years.

We conclude that a historical bottleneck effect took place around 1800 not only with regard to habitat and dead wood continuity, but also in terms of the related saproxylic beetles. In the early 19th century, overmature trees and decaying wood occurred particularly in extensively managed manor woodlands. In contrast, forest management in the state-owned woodlands was much more intensive and the number of habitat trees was reduced considerably. Furthermore, the private and corporation woodlands feature a greater historical connectivity than the state-owned woodlands, where populations of saproxylic beetles were more vulnerable due to habitat fragmentation.

For these reasons, the present private and corporation woodlands harbour a greater diversity of endangered and very demanding saproxylic beetles than the state-owned woodlands. Endangered saproxylic beetles mostly occur where suitable habitat structures outlasted the dramatic changes of the cultural landscape around 1800.

We recommend identifying and protecting those “hotspot” sites that feature a high diversity or relic occurrences of rare saproxylic beetles. In order to protect, to develop and to link these hotspots and their ecosystem services in private forests, we advise long-term arrangements with the forest owners. Additionally, special management concepts are essential to preserve those saproxylic beetles depending on old oak trees. Future habitat trees have to be supported in the surroundings of established beetle habitats, which can serve as contributing habitats.

O17 - A matter of diversity: how landscape related resource diversity benefits tropical pollinators

Sara Leonhardt[1], Benjamin Kaluza[1,2,3], Nora Drescher[3], Mohammad Katouli[2], Tim Heard[4], Helen Wallace[2]

[1]University of Würzburg, Würzburg, DE, sara.leonhardt@uni-wuerzburg.de
[2]University of the Sunshine Coast, Sippy Downs, AU
[3]Leuphana, Lüneburg, DE
[4]CSIRO, Brisbane, AU

Bees are highly important pollinators, but are threatened by anthropogenic activities that directly or indirectly affect the availability and diversity of flowering plants and hence the bees’ resources (pollen, nectar and resin). However, we still do not fully understand how resource availability and diversity and particularly their interactions with nutrient quality and functional efficiency affect bees.

To answer this question, we monitored resource intake and storage in the Australian stingless bee Tetragonula carbonaria (Apidae: Meliponini) in relation to landscape and resource diversity, and performed laboratory experiments on the functional efficiency of resin diversity.

We found that bees collected more different resources in suburban gardens than in their natural habitats (forests) or in agricultural landscapes. The nutritional quality of honey and pollen storages were similar across landscape, but total resource intake increased with increasing plant diversity and was highest in gardens. Moreover, laboratory experiments revealed that bees benefit from a variety of resin sources and that resin diversity and composition determine the functional efficiency of resin mixtures. However, high resource diversity is not necessarily associated with large proportions of natural habitats within the bees' foraging range. Instead small areas of diverse semi-natural habitat may sustain colonies even in intensively managed areas.

O18 - Landscape-wide crop heterogeneity vs. crop identity: enhanced percent maize reduces reproduction success of bumble bees

Annika Haß[1], Lara Brachmann[1,2], Péter Baráry[1], Yann Clough[3], Teja Tscharntke[1]

[1]Department of Crop Science, Agroecology, Georg-August-University, Göttingen, DE, ahass@uni-goettingen.de
[2]Albrecht-von-Haller-Institute for Plant Sciences, Department of Palynology and Climate Dynamics, Georg-August-University, Göttingen, DE
[3]Centre for Environmental and Climate Research, Faculty of Science, Lund University, Lund, SE

The decline of bees worldwide is alarming as they provide important pollination services that are essential for the reproduction of many crops and wild plant species. It is well-known that semi-natural habitats enhance pollinators; however, the demand of land for food and energy production is high and the influence of crop heterogeneity and crop identity besides mass-flowering crops is usually ignored.

We studied the effects of configurational and compositional landscape heterogeneity of crops (total edge length of fields and Shannon diversity of crop types) and the proportion of oilseed rape and maize on bumble bee colony growth, reproduction success and collected pollen diversity. We expected that higher heterogeneity as well as the increasing proportion of oilseed rape would result in larger colonies with higher reproduction success and pollen diversity of bumble bees.

Two colonies of *Bombus terrestris* were placed in each of 19 1x1 km landscapes in the surrounding of Göttingen. Colony weight was measured regularly and finally the number of large cells for queens was counted. Additionally, the pollen from three workers per colony was collected and pollen species were identified.

We found that landscape crop heterogeneity and the proportion of oilseed rape did not influence maximum colony weight, number of queens and pollen species richness. On the contrary, the proportion of maize in the landscape negatively affected the number of pollen species collected per colony and the number of queens produced.

The results suggest that crop heterogeneity can not improve habitat conditions for bumble bees and that crop identity is an important factor that should be considered in future studies. Intensively farmed spring crops with high herbicide and fertilizer application like maize can have negative effects on food diversity and reproduction success of pollinators and should be reduced in agricultural landscapes.

O19 - Plant-flower visitor networks, bumblebee pathogens and pollination service provision in anthropogenic habitats

Panagiotis Theodorou[1,2], Karoline Albig[1], Rita Radzeviciute[1], Josef Settele[2,4], Oliver Schweiger[4], Tomás E. Murray[1,3], Robert J. Paxton[1,2]

[1]Martin-Luther-University Halle-Wittenberg, Halle, DE, panatheod@gmail.com
[2]German Centre for Integrative Biodiversity Research (iDiv), Leipzig, DE, panatheod@gmail.com
[3]National Biodiversity Data Centre, Waterford, IE
[4]Helmholtz-Centre for Environmental Research – UFZ, Halle, DE

Pollination by insects represents a major ecosystem service vital to agriculture and essential for the maintenance of the structure and function of a wide range of natural communities. However, during the last decades numerous reports have shown declines in numbers of insect pollinators that can have major ecological and economic consequences. Two of the main global pressures on global biodiversity and animal pollinators are habitat change and degradation. Landscape alterations accompanying urbanization and agricultural intensification are likely to cause shifts in spatial distributions and species diversity across many animal and plant taxa. Within our study we examined how changes in both local habitat factors and large-scale spatial factors affect the abundance of pollinators and provision of the ecosystem service of pollination. Using sites in the federal state of Saxony-Anhalt (Germany) in the surroundings of Halle (Saale) that vary in their structural complexity, we studied the effect of land-use on mutualistic communities. We established experimental self-incompatible plant communities, we monitored the abundance of flying insects and we simultaneously quantified provision of the ecosystem service of pollination. Moreover, we built plant-flower visitor mutualistic networks at each site to assess how changes in community structure resulting from local habitat quality and landscape variations affect network architecture. To further assess possible top-down effects of parasitism on pollination, principal pollinators were sampled and screened for parasites using molecular markers. We present the main results of these empirical analyses that explore multiple potential drivers of the biodiversity-ecosystem services relationship for a major ecosystem service: pollination.

O20 - Benefits of flowering fields to pollinators in relation to landscape context

Daniela Warzecha[1], Frank Jauker[1], Tim Diekötter[2], Volkmar Wolters[1]

[1]Justus Liebig University, Department of Animal Ecology, Heinrich-Buff-Ring 26-32, D-35392 Giessen, DE, Daniela.Warzecha@allzool.bio.uni-giessen.de
[2]Christian-Albrechts-University, Department of Landscape Ecology, Olshausenstrasse 75, D-24118 Kiel, DE

The aim of agri-environmental schemes is to support biodiversity by funding farmers for environmentally friendly management. Sown wild-flower fields are an established method for promoting pollinators by counteracting detrimental effects of habitat fragmentationand resource limitation in homogeneous landscapes. While it has already been shown that pollinators generally benefit from increased flower availability, it remains unclear in which landscape context the conservation and restoration of pollinator communities is most efficient.

We assessed wild bee diversity and abundance in 22 crop fields transformed in flowering fields and monitored the community structure over 3 years. The study sites were situated in an agricultural landscape near Marburg, Germany, and spanned a gradient in landscape complexity from low to high amounts of arable land within a 500m radius. Half of the sites were isolated flowering fields, the other half was connected to additional flowering field of similar size.

A total of 4575 individuals out of 112 wild bee species were collected over the whole sampling period. Species number and abundance was highly variable among years, with a generally declining trend. Within years, species richness was negatively correlated with the amount of arable land, whereas abundance remained constant for the first two years. Species richness was positively correlated with semi-natural structures in the surrounding landscape over all years.

Flowering fields are utilized by >25 % of the regional species pool in Hessen. While the surrounding landscape is the main driver for the colonization success of newly established habitats, it has little effect on counteracting diversity fluctuations over time. Instead, dominant species benefit disproportionally in poor years. Thus, flowering fields are valuable tools for promoting ecosystem services in simplified landscapes, but show their highest potential for biodiversity conservation in complex landscapes.

O21 - Seminatural habitats enhance pollination of pumpkin

Sonja C. Pfister[1], Philipp Wolfgang Eckerter[1], Julius Krebs[1], Jens Schirmel[1], Martin H. Entling[1]

[1]University Koblenz-Landau, Institute for Environmental Sciences, Landau, DE, pfister@uni-landau.de

Pollination is a valuable ecosystem service for agriculture. In Europe over 80% of crop species benefit or even depend upon insect pollination. However, most pollinators in agricultural landscapes depend on seminatural habitats (snh) for additional food resources, nesting and overwintering sites. Still, it is poorly understood which snh types are most beneficial and if there are interactive effects between directly adjacent field margins and the surrounding landscape. We investigated how landscape composition (% snh in 1 km radius) and the adjacent snh type (woody, herbaceous, or another field as control) influenced pollinators and pollen delivery in 18 pumpkin fields in the Upper Rhine Valley, Germany. We studied pumpkin (*Cucurbita maxima*) because it is obligate cross-pollinated and has local economic value. Pollinators were sampled by video recording (total of 180 min per field) and pollen delivery by quantifying the number of pollen on the stigmas. In our study region pumpkin flowers are visited mainly by honeybees (80% of visits), followed by bumblebees (14%) and halictid bees (6%). However, pollen numbers on stigmas increased most strongly with the number of bumblebee visits, while other visitors had no significant effect. Bumblebees may be more consistently effective pollinators of pumpkin than honeybees, which are known to vary strongly in their effectivity. The abundance of bumblebees increased with the percentage of snh in the landscapes and was higher adjacent to open habitats (field or herbaceous snh) than to woody snh. Pollen delivery was also positively correlated with landscape complexity. Pollination increased with increasing distance to woody field margins (up to 26 m). This pattern is likely due to a shading effect. Our data suggest that wild pollinators and especially bumblebees are important for pumpkin pollination in spite of the numerical dominance of honey bees. Landscape complexity can therefore enhance pollination services.

O22 - The insurance effect of wild pollinators on almond farmers‘ income

Yuki Henselek[1], Alexandra-Maria Klein[2], Stefan Baumgärtner[1]

[1]Environmental Economics and Resource Management, University of Freiburg, Freiburg, DE, yuki.henselek@ere.uni-freiburg.de
[2]Nature Conservation and Landscape Ecology, University of Freiburg, Freiburg, DE

Food production depends partly on insect pollination as about 35% of the world crop production volumes rely to some degree on crop pollination services. Some farmers such as many fruit producers rely solely on pollination services by the honey bee (*Apis mellifera*), although wild pollinating species are known to be effective pollinators, too.

Here, we study how wild pollinators such as several wild bee species (e.g., *Andrena* spp., *Osmia* spp.) and hover flies (Syrphidae) affect the probability distribution of pollination services and thus, farm income. Therefore, we analyze data from an existing data-set about species-specific flower visits in almond orchards (Klein et al. 2012). Our study is novel and innovative for three reasons:

1. We use a combinatorial model of effective pollination through a sequence of

flower visits by pollinators to upscale the data from the level of field observation during a limited time interval to the level of overall pollination services during an entire season.

2. Using agronomic and economic data, we convert this pollination probability distribution into an income probability distribution and thus, present a monetary evaluation.

3. We use statistical methods to analyze the resulting income probability distribution in terms of its mean, standard deviation/coefficient of variation and skewness.

Our results show that wild pollinators lead to an increase in the mean farm income, especially when the surrounding habitat has a high percentage of natural habitat. Additionally, wild pollinators increase the standard deviation of income, yet decrease the coefficient of variation, i.e. normalized standard deviation. They lead to a right skewed income distribution, that is, they enlarge the range of the income distribution and shift probability mass in particular to higher incomes.

Thus, wild pollinating species contribute substantially to farm income and can partly compensate for the provision of pollination services by the honey bee. This can be seen as an insurance effect against the possible loss of pollination services by the honey bee and thus, farm income.

A.-M. Klein, C. Brittain, S. D. Hendrix, R. Thorp, N. Williams and C. Kremen. 'Wild pollination services to California almond rely on semi-natural habitat'. In: Journal of Applied Ecology 49.3 (2012), pp. 723-732.

O23 - Subsidized flowering fields promote prey-hunting wasps through increased habitat connectivity

Uta Sophie Hoffmann[1,2], Tim Diekötter[2], Jonathan Lanzen[3], Volkmar Wolters[1], Frank Jauker[1]

[1]Department of Animal Ecology, Giessen, DE
[2]Department of Landscape Ecology, Kiel, DE
[3]Department of Animal Ecology and Tropical Biology, Würzburg, DE

Habitat fragmentation constitutes a main driver of biodiversity decline in agroecosystems. Subsidized flowering fields are thought to counteract this decline. While their benefits for pollen-collecting insects are obvious, little is known about their effects on flower visitors with carnivorous larvae. Here, we studied whether flowering fields provide not only nectar for adults but also larval prey for the common trap-nesting wasps *Ancistrocerus nigriconis* and*Trypoxylon figulus*.

Twenty-two woody semi-natural habitats in central Germany were selected as trapnest locations forming independent gradients in distance to the next flowering field and complexity of surrounding landscape (500m scale). Half of these sites had only one, the other half an additional flowering field in the surrounding. Trap-nests were controlled weekly for newly built nests from May to July 2012. For each nest, we recorded the number of prey items, prey (morpho-)species and prey weight. Two cells were left undisturbed for subsequent wasp identification.

In total, 628 nests with 3820 brood cells were recorded for the study species. The caterpillar-hunting *A. nigricornis* showed a high nest-building activity in complex landscapes and close to flowering fields. Additional flowering fields intensified the positive effect of landscape complexity, but if flowering fields were scarce, cells were provisioned with low prey quality and quantity even in complex landscapes. However, the spider-hunting *T. figulus* showed a strong bottom-up effect, as increase of prey quality and quantity with increasing landscape complexity was mirrored by increased nest-building activity when flowering fields were scarce.

In conclusion, flowering fields promote prey-hunting wasp species, especially in simple landscapes. Because wasps are at a higher trophic level than wild bees, they may be more sensitive to landscape changes and may require higher habitat connectivity for their ecological functions in agroecosystems.

O24 - Wildflower strips enhance biological pest control and yield

Matthias Tschumi[1,2], Matthias Albrecht[1], Cédric Bärtschi[1,3], Jana Collatz[1,3], Martin H. Entling[2], Katja Jacot[1]

[1]Agroscope, Institute for Sustainability Sciences, Zürich, CH, matthias.tschumi@agroscope.admin.ch
[2]University of Koblenz-Landau, Institute for Environmental Sciences, Landau (Pfalz), DE, matthias.tschumi@agroscope.admin.ch
[3]ETH Zurich, Institute of Agricultural Sciences, Zürich, CH

Sown flower strips are increasingly implemented within agri-environment schemes (AES) to increase farmland biodiversity and ecosystem services, such as pollination or biological pest control. Whereas the effectiveness of AES in promoting farmland biodiversity has been repeatedly evaluated in the last decade, their effects on biodiversity-mediated ecosystem services such as natural pest control remain poorly studied and the consequences on crop damage and yield have rarely been quantified. We assessed the effect of perennial, species rich wildflower strips, primarily aimed at conserving farmland biodiversity in Swiss AES, on pest control in nearby winter wheat crops. We found strong reductions in the density of cereal leaf beetles *Oulema sp.* and in plant damage in winter wheat close to sown wildflower strips compared to control fields without wildflower strips. Moreover, yield was increased by 10% in winter wheat adjacent to wildflower strips. Among the tested flower strip properties, flower abundance and diversity were the best predictors of pest control and yield. These findings demonstrate that wildflower strips, with known positive effects on biodiversity, also promote biological pest control and crop yield. This highlights the potential of AES to contribute to ecological intensification and may encourage farmers to adopt such schemes.

P1 - Artificial and natural key habitats increase the resilience of herpetofauna in a heavily impacted tropical dry forest

Maike Guschal[1,2], Eliza M. X. Freire[3], Jarcilene S. A. Cortez[4], Raffael Ernst[1,2]

[1]Senckenberg Natural History Collection, Dresden, DE, maike.guschal@senckenberg.de
[2]Technical University of Berlin, Berlin, DE, maike.guschal@senckenberg.de
[3]Universidade Federal de Rio Grande do Norte, Natal, BR
[4]Universidade Federal de Pernambuco, Recife, BR

The large semi-arid ecosystem of northeastern Brazil, the Caatinga, is considered one of the most threatened ecosystems on the planet. Intensified land-use and climatic extreme events enhance degradation and loss of natural habitats, while novel artificial habitats are being created at the same time. Whether this mix of natural remnants and newly created habitats has the potential to maintain a substantial part of the ecosystem's biodiversity and prevent further diversity decay is yet to be tested. This study aims at quantifying the role of two key habitats (1. Natural patches of the bromeliad *Encholirium spectabile* =Macambira, 2. Artificial aquatic sites built for irrigation and as dew ponds) in maintaining diversity and increasing resilience in herpetofaunal assemblages of a heavily disturbed dry forest system at Itaparica Reservoir, Pernambuco, Brazil. Data were generated through visual and acoustic encounter surveys along 50 transects at natural and artificial water bodies, as well as in 30 Macambira patches applying a repeated total removal scheme. In total we recorded 17 species of amphibians and 21 species of reptiles. Results showed that Macambira patches play an important role for the occurrence of selected focal species and they were identified as natural key habitats. Herpetofaunal diversity within natural bromeliad patches depended on patch size and degree of isolation to other patches. Frequent cutting of bromeliad patches as livestock fodder are expected to cause a decrease in reptile species richness. Artificial aquatic habitats turned out to be important alternative reproductive habitats for selected amphibian taxa particularly under severe climatic conditions. Both natural and artificial key habitats thus play an important role in mitigating effects of land-use and climate extremes and have the potential to increase resilience of this fragile forest ecosystem.

P2 - Effects of irrigation and fertilization on grasshopper diversity in meadows

Isabelle Schröder[1], Constanze Buhk[1], Rebekka Gerlach[1], Jens Schirmel[1]

[1]Institute of Environmental Science, University of Koblenz-Landau, Fortstraße 7, 76829 Landau, DE

Grassland ecosystems have dramatically declined in Europe due to agricultural intensification and the abandonment of traditional management. In Central Europe, lowland meadow irrigation was a widespread traditional management practice to increase hay yield. Nowadays it is mostly abandoned and traditionally irrigated

meadows with their associated species are restricted to few remnant areas. In this study we analyzed the effects of traditional meadow irrigation and fertilization on the (functional) diversity of grasshoppers. Therefore we sampled grasshoppers with a boxquadrat in 28 meadows which differ in their irrigation status (14 irrigated, 14 non-irrigated) and fertilizer applications (10 non-fertilized, 10 with 30-50 kg N/ha, 8 > 50 kg N/ha) in the 'Queichtal' near Landau, Rhineland-Palatinate, Germany. As a measure for vegetation structure, the aboveground plant biomass was also recorded. We calculated the Simpson index to express alpha diversity, the homogeneity of multivariate dispersion as a measure of beta diversity, and functional dispersion (FDis) using multiple species traits as an index for functional diversity. As main results, alpha and functional diversity reacted similarly and were both negatively correlated with vegetation biomass and tended to be lower in irrigated meadows. FDis was additionally negatively affected by fertilization and lowest in meadows with the highest N fertilizer applications. Beta diversity, however, (community differentiation) was higher in irrigated than in non-irrigated meadows and did not differ among the three fertilization levels. Our results suggest that the most productive meadows, either through high fertilizer amounts or irrigation, are characterized by species-poor grasshopper assemblages with low functional diversity. In contrast, irrigation enhanced beta diversity which might be explained by the heterogeneous irrigation among meadows. To conclude, fertilization has detrimental effects especially on the functional diversity of grasshoppers while meadow irrigation might be important to maintain high beta diversity.

P3 - Extinction by forestry? Empirical evidence for decreasing species richness of saproxylic beetles since the 19th century in Hesse (Germany)

Peter Meyer[1], Ulrich Schaffrath[2], Marcus Schmidt[1]

[1]Nordwestdeutsche Forstliche Versuchsanstalt, Göttingen, DE
[2]Büro Dr. Schaffrath, Kassel, DE

Saproxylic species account for a high proportion of overall species richness in temperate forests. According to current red lists many saproxylic species are particularly endangered, with forestry considered as the main threat. However, objective evidence for decreasing richness of saproxylic species over longer periods of time is largely lacking.

For the German federal state of Hesse we collected all published surveys of a group of 115 beetles considered to be closely associated with habitat continuity of primeval forest structures, in particular dead wood and mature trees ("Urwald relict species"). In a database 1,560 records with information on species name, number of individuals, locality, year and name of collector were compiled spanning from the year 1790 to 2014.

Data were analyzed using the R-package "rich". We treated each record of one collector in one specific year and locality as one sample. Overall 6,327 individuals of

68 species in 763 samples were registered. From the year 1840 onwards samples were pooled for periods of 30 years with an overlap of 25 years. Rarefied as well as cumulative species richness (CSR) were calculated for each time frame on the basis of 100 randomized iterations.

Average CSR in the mid of the 19th century amounted to 61 species and was significantly higher than current CSR (49 species). Yet, current CSR is significantly higher than CSR calculated for the first half of the 20th century (32 – 40 species), which indicates a certain recovery of the group of “Urwald relict species”. Rarefaction reveals similar results but shows a less prominent and non-significant recovery of species richness.

Our study provides data-based evidence for a significant loss of richness of a saproxylic species group over the last two centuries. Most probable drivers of this process are the large-scale conversion of traditionally managed woodlands (coppice, coppice with standards, pasture woodlands) into high forests and coniferous stands in combination with increasing accessibility of forest landscapes and the subsequent spatial homogenization of cutting intensity.

P4 - Landscape vs local effects on insect herbivory in fragmented calcareous grasslands

Maria Rosa Rossetti[1], Verena Rösch[2], Martín Videla[1], Teja Tscharntke[2], Péter Batáry[2]

[1]Universidad Nacional de Córdoba, IMBIV-Centro de Investigaciones Entomológicas de Córdoba, Córdoba, AR, rossettimariarosa@gmail.com
[2]Georg-August-University, Agroecology, Göttingen, Göttingen, DE

Insect herbivory can shape the structure of plant communities by influencing the competitive dynamics among plant individuals. Herbivory patterns depend on factors acting at different spatial scales. Habitat fragmentation, the reduction of habitat fragment size and increasing habitat isolation, is a landscape level effect and can cause species loss of herbivores that in turn may decrease herbivory. Composition and configuration of the surrounding landscape can influence species movement among habitat fragments, potentially leading to alterations of herbivory. Additionally, other factors operating at the local scale like vegetation height and species richness of plants can directly affect herbivore diversity and herbivory. This study aimed to examine the relative effects of landscape fragmentation (fragment size, connectivity of fragments and percentage of arable land in the surrounding landscape) and local characteristics within fragments (herb species richness and height, grass cover and bare soil) on insect herbivory. We selected 28 calcareous grasslands in Central Germany, one of the ecosystems with the highest diversity of plant and animal species in Europe. We measured leaf area damaged through visual inspection of all herbs in 12 plots (50 × 50 cm) per fragment. Grass cover, species richness and height of herbs and bare soil were estimated in each plot. Herbivory was analysed with general linear models. Herbivory was positively related to grass cover and herb height at the local scale and higher in small than large grasslands as the only landscape influence. The effects of the local predictors were stronger than the landscape effect. Higher herbivore pressure at increasing grass cover and herb height could be associated with herbivore concentration on the remaining and more apparent herbs. The landscape effect could imply that herbivores may be released from natural enemy control and increase their damage in small grasslands.

P5 - Phylogenetic diversity increases invertebrate herbivory in managed grasslands

Eugen Egorov[1], Martin M. Gossner[2], Sebastian T. Meyer[2], Wolfgang W. Weisser[2], Martin Brändle[1]

[1]Department of Ecology - Animal Ecology, Faculty of Biology, Philipps Universität Marburg, Marburg, DE, eugen.egorov@staff.uni-marburg.de
[2]Terrestrial Ecology Research Group, Department of Ecology and Ecosystem Management, Center for Food and Life Sciences Weihenstephan, Technische Universität München, Freising- Weihenstephan, DE

Recently it has been proposed that considering the phylogenetic structure of plant communities may improve our understanding of the mechanisms behind the diversity herbivory relationships. Invertebrate herbivores often show food specialization to some degree caused by preferences to phenotypic plant traits, which are conserved within certain plant lineages. While many of these traits are difficult to assess or are even unknown, phylogenetic diversity provides a single measure that incorporates the trait space of a plant community. Here, we analyzed the relationship between invertebrate herbivory and plant phylogenetic diversity in managed grassland. Specifically we aim to test (i) whether phylogenetic diversity is a stronger predictor of invertebrate herbivory than plant species richness and (ii) whether land-use effects on herbivory are mediated by plant phylogenetic diversity.

We assessed invertebrate herbivory and plant diversity across a range of land-use intensities including a total of 145 managed grasslands in three regions in Germany (Biodiversity Exploratories: Schwäbische Alb, Hainich-Dün and Schorfheide-Chorin). Land use affected plant species richness and phylogenetic diversity negatively. Plant species richness was only a poor predictor of herbivory. By contrast, plant phylogenetic diversity had a strong positive effect on herbivory even after accounting for the effects of region and land use. The strength of direct and indirect effects of land use and phylogenetic diversity, however, varied among regions.

Our results suggest that increasing phylogenetic diversity of plant communities increases invertebrate herbivory probably by providing more food resources. Differences among regions suggest to account for regional peculiarities when attempting to generalize plant community phylogenetic- and land-use effects on invertebrate herbivory.

P6 - Which process drives local abundance of true bug species in managed grasslands?

Nicolas Frieß[1], Martin M. Gossner[2], Wolfgang W. Weisser[2], Martin Brändle[1]

[1]Faculty of Biology, Department of Ecology - Animal Ecology, Philipps-University of Marburg, Marburg, DE
[2]Terrestrial Ecology Research Group, Department of Ecology and Ecosystem Management, Technische Universität München, Freising, DE

The variation in abundance among species may be caused by (1) local processes such as the resource availability or biotic interactions, (2) regional processes such as species distribution or (3) processes linked to species traits such as body size, specialization or tolerance to environmental change. To test the importance of these processes we investigated local abundances of true bug species (Heteroptera) in managed grasslands of the Biodiversity Exploratories (Schwäbische Alb, Hainich-Dün and Schorfheide-Chorin). Specifically we aimed to answer the following questions: (1) Does local abundance increase with resource availability? (2) Does local abundance of species increase with regional distribution, species range size or with decreasing distance to the distribution center? (3) Does local abundance increase with decreasing body size? Are specialized species rarer than generalist species? Does local abundance increase with tolerance to land-use?

Local abundance of 70 true bug species was related to species ranges on different geographic scales (local occupancy = number of plots occupied, Germany, Central Europe, Europe and Palearctic), the distance to the centroid of the Palearctic distribution area, resource availability (local plant abundance), body size, host-plant specialization and tolerance to land-use. Univariate analysis revealed a strong positive relationship between mean abundance and local occupancy in all three exploratories. We also found a weak positive relationship between mean abundance and resource availability as well as the tolerance to land-use. Multimodel averaging however revealed the local occupancy of species as the only important predictor for the mean abundance of true bug species.

Overall our results show that the variation in species abundance is driven by regional processes. We found no evidence for bottom-up regulation by host plants. Body size, specialization and tolerance to land-use were only poor predictors for the mean abundance of true bug species.

P7 - Impacts of land use change on the biodiversity of bumblebees, grasshoppers and ecosystem services

Ronnie Walcher[1]

[1]Institute of Zoology, Department of Integrative Biology and Biodiversity Research, Vienna, AT, ronnie.walcher@boku.ac.at

In different European countries land use abandonment of traditionally managed meadows, especially in montane and alpine regions, is an ongoing problem due to poor accessibility, low economic value and high labour input. Due to land use change and abandonment of traditionally managed meadows in montane and alpine regions, very valuable habitats that harbour a high biodiversity, get lost affecting both the faunistic and floristic diversity. After land abandonment shrubs and competitive grass species increase because of secondary succession and alter the habitat quality for many species depending on traditionally managed meadows.

The following study aims at investigating whether and to what extent there is an influence of land use abandonment on bumblebees, grasshoppers and heteropteran bugs. Grasshoppers and bugs are known to be influenced by land use change due to the loss of favourable habitat conditions especially for larvae. Bumblebees are very important pollinators that need flower-rich habitats for foraging and these insects may be strongly affected by land use abandonment of traditionally managed meadows.

In the present study the diversity of bumblebees, grasshoppers and bugs are measured in three regions across the Alps. Study regions are located in the Biosphere Reserve Val Müstair (Graubünden, Switzerland), in the Biosphere Reserve Großes Walsertal (Austria) and in the LTSER-region Eisenwurzen (Austria). Within each study region three abandoned and three extensively managed semi-dry calcareous meadows (mowed once a year, no fertilizer use) are investigated measuring richness, abundance and species assemblages of bumblebees, grasshoppers and bugs. Measurements of bumblebee and bug diversity will be conducted in late May/early June and August 2015. Grasshopper diversity is measured once in August 2015. A novel approach is the use of soundscapes assessing grasshopper diversity like enabling to cover nearly all grasshopper species occuring in their habitat.

It is hypothizised that there is a difference in species richness, abundance and species assemblages of bumblebees, grasshoppers and bugs between managed and abandoned semi-dry calcareous meadows. It is further assumed that extensive management plays a key role for enhancing biodiversity.

P8 - Landscape simplification increases competition between managed honey bees and wild bumble bees

Lina Herbertsson[1], Sandra Lindström[2,3,4], Maj Rundlöf[4], Riccardo Bommarco[2], Henrik Smith[1,4]

[1]Centre for Environmental and Climate Research, Lund University, Lund, SE, lina.herbertsson@cec.lu.se
[2]Department of Ecology, Swedish University of Agricultural Sciences, Uppsala, SE
[3]Swedish Rural Economy and Agricultural Society, Kristianstad, SE
[4]Department of Biology, Lund University, Lund, SE

Wild bees are declining and one of the reasons is expected to be loss of forage resources due to agricultural intensification and landscape simplification. In addition, honey bees may compete with wild bees by depleting common resources. To examine if competition between honey bees and bumble bees depends on the landscape context, we manipulated honey bee abundances in 19 spatially separated landscape sectors (1 km radius). Sites were located in simple or complex landscapes, differing in the proportion semi-natural grasslands, and generally also in the amount of permanent field border. We added honey bee hives to nine of the sites and ensured that the remaining ten sites were free from hives. Supplementation with honey bees suppressed bumble bee abundances in simple landscapes, but not significantly so in complex landscapes. In complex landscapes, the addition of honey bees instead reduced the proportion of bumble bee species with small foraging ranges. This finding suggests that the effect is caused by lack of food and slower colony growth, rather than avoidance of the honey bees, which likely would have reduced the proportion of the most mobile species. In line with some previous studies, our results indicate that honey bees compete with wild bees, but also that this can be mitigated by an increase in permanently flower-rich habitats.

P9 - Effects of management intensity on plant biodiversity and related ecosystem services in Austrian and Romanian vineyards

Silvia Winter[1], Daniela Popescu[2], Maria Comsa[2]

[1]University of Natural Resources and Life Sciences Vienna, Vienna, AT, silvia.winter@boku.ac.at
[2]Research-Development Station for Viticulture and Enology Blaj, Blaj, RO

Vineyards may be biodiversity-rich habitats. Within vineyards, the land-sharing *vs.* land-sparing debate would be in principle less of an issue, as areas between vine rows could host a diverse flora of local species or cover crops. Traditionally, landscape elements such as solitary trees, hedges and stone walls are also important elements of diverse temperate viticultural agroecosystems. These elements also provide important ecosystem services including erosion mitigation, habitat and food sources for natural enemies and also fruits. In addition, biologically and structurally diverse viticultural landscapes provide a high aesthetic value for recreation and tourism. However, these multifunctional viticulture agroecosystems are declining, due to more intensified and increasingly mechanized management.

Traditional vineyard management was characterized by frequent tilling in order to eradicate all spontaneous plants ('weeds') and to reduce water and nutrient competition between vines and such weeds. Later, herbicides were frequently used for removing these weeds. These management measures are nowadays associated with ecosystem disservices such as very high rates of erosion, degradation of soil structure and fertility, contamination of groundwater and high levels of agricultural inputs such as pesticides.

In the BiodivERsA project VineDivers, we analyze the effects of different management intensities (high intensity tilling regimes *vs*. permanent or temporary vegetation cover) on above- and below-ground biodiversity and the associated ecosystem services across Europe. We established plots in vineyards of high and low intensity management within landscapes of low to high structural diversity. In this paper we want to present the first results of the plant biodiversity survey. Up till now, we recorded plant biomass and biodiversity in 48 Austrian and Romanian vineyards. We will discuss the results of the vegetation survey in view of related ecosystem services in vineyards.

P10 - Effects of mowing and grazing on plant diversity and vegetation heterogeneity in semi-natural grasslands

Antje Kautzner[1], Harald Auge[1], Cornelia Baessler[1], Stefan Klotz[1], Thomas Reitz[2], Christiane Roscher[1], Elke Schulz[2], Tesfaye Wubet[2]

[1]Helmholtz Centre for Environmental Research - UFZ, Department of Community Ecology, Halle (Saale), DE, antje.kautzner@ufz.de
[2]Helmholtz Centre for Environmental Research - UFZ, Department of Soil Ecology, Halle (Saale), DE

Grasslands rank among the most species-rich ecosystems in Central Europe. In most cases they originate from anthropogenic practices and depend on ongoing management. It is known that the land-use type, mowing or grazing, has great impact on species composition but the differential effect of these two types of management on plant diversity in semi-natural grasslands is still unclear.

In our study we took up this issue and chose 34 managed grassland sites in six regions of Central Germany to investigate how meadows and pastures differ in plant species richness and small-scale spatial heterogeneity of vegetation composition, considering land-use intensity by using the land-use intensity index of Blüthgen et al. (2012). Furthermore, we asked how these properties are linked to characteristics of the study regions, like climatic conditions, landscape structure and soil properties. We expected meadows, which are characterized by a moderate spatially homogeneous disturbance regime, to be less spatially heterogeneous than pastures, where trampling, feeding preferences of livestock and patchy deposition of animal faeces create a small-scale mosaic of different disturbances and nutrient availabilities. Preliminary results suggest that this is not the case in our study. Grasslands of both land-use types do not differ in small-scale heterogeneity of species composition and show, on average, similar species richness across different spatial scales. In contrast, regional effects as well as land-use intensity seem to have a greater impact on plant diversity.

P11 - Populations of Agrostemma githago L. from Kosovo and Germany differ in species traits

Annalena Heide[1], Anna-Lena Dietz[1], Rainer Waldhardt[1]

[1]Justus Liebig University Giessen, Giessen, DE, a.heide@online.de

Agrostemma githago was a widespread weed all over Europe until about 1950. For several reasons related to the intensification of agriculture *Agrostemma githago* has an extremely high extinction risk in many parts of Europe today. However, on the Balkan Peninsula (e.g. in Kosovo) this weed species is still among the common weeds. In 2014, we studied the germination behaviour of *Agrostemma githago* populations from Germany and Kosovo in climate chambers at Giessen University. In two-week experiments, we estimated the optimum temperature for seed germination and quantified the impact of pre-frost treatment of the seeds and of water availability on the germination rates. Results clearly show that the studied populations differ in species traits: The population from Kosovo possesses a more asynchronous germination strategy and the seeds are more frost resistant than those from the German population.

P12 - Biodiversity in Legume-Supported Cropping

Georg Everwand[1], Jens Dauber[1]

[1]Thünen Institute of Biodiversity, Braunschweig, DE, georg.everwand@ti.bund.de

Legumes as N-fixing plantswere known for their beneficial effects within the crop rotation or as protein source in animal and human nutrition by european farmes for centuries. Yet, traditional legume-supported systemsdiminished within the last century in the course of agricultural intensification, since cheap fertilizers, crop protection products and protein crop imports for food and feed became increasingly available on the global market. Currently, coming along with the development and application of European national protein crop strategies, legume-supported cropping systems receive a revival. The aim of those strategies is, among other things, to strengthen local protein crop production, to establish more resource efficient, sustainable and nonetheless productive agricultural system and to tackle the rapidly growing negative environmental impacts of agricultural intensification. Within the «greening» of the Common Agricultural Policy (CAP), legume-supported cropping is eligible as ecological focus area with the aim to support biodiversity.

The eligibility is based on the expectations that biodiversity will profit from:

- More diverse crop rotations and landscapes
- Promotion of pollinators and other beneficial organisms
- Reduction of chemical crop protection and fertilizer application

The scientific evidence of those expected beneficial effects of legumes on biodiversity, however, appears to be weak or missing. Therefore, we are conducting a literature review with a focus on the interactions between legume traits, such as flowering or N-fixation, and the agricultural management of the respective legume-supported cropping systems. These interactions are often neglected but involve important constraints for achieving true biodiversity benefits. This is in particular the case for legume crops under conventional agricultural management (including ecological focus areas) for which for instance the use of chemical crop protection is allowed. This, in combination with relatively short growing seasons or harvesting of the legume crop before flowering, raises some doubt about the usefulness of this measure for improving biodiversity. Here we present some results from the literature review with the aim to give concrete recommendations for improving biodiversity measures within the CAP post 2020.

P13 - Consistent Decline in the Abundance of Epigeic Soil Animals with Elevation

Juliane Röder[1], Roland Brandl[1]

[1]Philipps University, Marburg, DE, juliane.roeder@biologie.uni-marburg.de

Species diversity is the most common variable reported in recent ecological research articles. Ecological processes, however, are driven by individuals. High abundances make arthropods, despite their small body sizes, important actors in food webs. The influence of climate on abundances of arthropods and their involvement in ecological processes is becoming an important question in the light of global change. Elevation gradients offer the opportunity to study the response of arthropod assemblages to climatic conditions in a space-for-time approach. We sampled arthropod assemblages with pitfall traps in disturbed and undisturbed vegetation types along an elevation gradient of 3600 m on the slopes of Mt. Kilimanjaro, Tanzania. In our analysis, we focused on 13 different lineages of arthropods that are known to be sampled well with pitfall traps, and that represented three major functional groups: predators, herbivores and decomposers. Overall abundance of arthropods and seven of the 13 studied lineages declined significantly with elevation. When we assigned arthropods to three functional groups, all three groups declined in abundance towards higher elevations as well. However, when we assigned Coleoptera to the same functional groups at family level, predatory beetles showed a unimodal pattern, and herbivore beetles did not change in abundance along the gradient. Only beetles involved with decomposition declined in abundances like the other arthropod decomposers. There were only minor differences between undisturbed and disturbed vegetation types at all levels of taxonomic and functional resolution. The fact that we found different trends in the response of arthropod abundance depending on the level of taxonomic and functional resolution highlights the need for more comparisons of different lineages along the same climatic gradients. This information is necessary to understand the respective involvement of arthropods in ecological processes under natural conditions.

P14 - Decomposition of root litter mixtures in a subtropical forest in southern China

Yinong LI[1], Xi Chen[1], Ciska Veen[1], Xiaomei Zhou[1], Naili Zhang[1], Keping Ma[1]

[1]Naili Zhang, Beijing, CN

Backgrounds and Aims fine root decomposition plays a critical role in regulating organic matter dynamics and nutrient release and nearly accounts for 56 % of total plant tissue turnover in forest ecosystems. However, we know little about root mixture decomposition. Given that high diversity could provide a wide range of chemical and physical diversity of root litter, we hypothesize that root mixture with high diversity could stimulate growth and activity of microbial decomposers and consequently have higher decomposition rate.
Methods we established a field experiment of root mixture decomposition in 2011 in a subtropical forest in southern China. The experiment had been continuously conducted for three years. The roots collected from eight plant species were mixed according to random partition design following a broken stick procedure. Briefly, eight plant species were randomly partitioned into two mixtures of four plant species, and the partitioning process was continued with each resulting mixture. As such, we obtain two mixtures of two plant species from each resulting four the mixture plant species. Overall, four diversity levels including single plant species, two, four and eight plant species were established to test diversity effects on fine root decomposition. During the experimental period, root mass loss and soil parameters have been measured to test the diversity effect of root mixture on decomposition.

Results and Discussion we found significant diversity effects on fine root litter decomposition. Interestingly, many litter bags had been bitten by some macro-fauna during the experimental period, allowing us to test the effect of macro-fauna activities on root decomposition. Our findings showed that soil macro-fauna activities generally increased the root mass loss and modified the pattern of diversity effects on root decomposition. The result supports our hypothesis that high diversity could stimulate fine root decomposition but only when there is no effects of macro-fauna activities. Further efforts such as measurement of microbial decomposers need be made for better elucidating underlying mechanisms of diversity effect on root decomposition.

P15 - Effects of crop residues on resource utilization and community structure of soil arthropods in arable fields

Nicole Scheunemann[1], Olaf Butenschoen[1], Stefan Scheu[1]

[1]University of Goettingen, Goettingen, DE, nscheun@gwdg.de

Agroecosystems cover wide areas of the terrestrial land surface and are inhabited by many species of soil arthropods, e.g. collembolans, mites, spiders and beetles. In recent years it has become common practice to remove crop residues, i.e. shoots and leaves, from the field after harvest, e.g. for bioenergy production. Since crop residues are the main resource for saprotrophic soil arthropods, shoot residue removal is expected to detrimentally affect soil animal communities.

In a long term field experiment we investigated the abundance and resource utilization of soil arthropods in arable fields planted with maize or wheat, respectively, with and without the application of maize shoot residues at the soil surface after harvest. Benefitting from natural differences in $^{13}C/^{12}C$ ratios between wheat (C3 plant) and maize (C4 plant) we determined the contribution of root-derived and shoot residue-derived carbon (C) to soil arthropod body C.

After one year of the experiment shoot residue addition affected soil arthropod abundances only little. Most species incorporated more root-derived than shoot residue-derived C, suggesting that belowground resources, i.e. roots and root exudates, are far more important for the soil arthropod communities of arable fields than aboveground resources provided by shoot residues.

Notably, in general, soil arthropod abundances were significantly higher in wheat than in maize fields, presumably due to higher amounts of fine roots and more favourable climatic conditions in wheat than maize fields. Overall, this suggests that plant identity overrides the importance of aboveground residues for soil arthropod communities in arable fields. Therefore, removal of crop residues may be less important for soil animal communities than crop identity.

P16 - Impact of root herbivory on plant interactions with above- and below-ground organisms at different land use intensities

Ilja Sonnemann[1], Yvonne Buchholz[1], Daniel Rautenberg[1], Susanne Wurst[1]

[1]Functional Biodiversity, Freie Universität Berlin, Berlin, DE, i.sonnemann@fu-berlin.de

Root herbivory can influence plant interactions with other organisms by systemically affecting plant morphology and chemistry. We established local *P. lanceolata* plants in grasslands sites with and without root feeding *Agriotes spp*. larvae (Coleoptera, Elateridae) in their root system. We found that the strength and direction of the root herbivore impact on plant interactions with aboveground as well as belowground organisms depended on land use intensity. Thus, land use intensity may determine the net effect of root herbivory for plant performance. Defense chemistry of *P. lanceolata* will be analyzed to elucidate mechanisms behind root herbivore effects.

P17 - Importance of functional weed diversity on phosphorus cycling in Brazilian banana fields

Veronika Pfaffenberger[1], Jarcilene Almeida-Cortez[2], Arne Cierjacks[1]

[1]Universität Hamburg/ Biodiversität der Nutzpflanzen, Hamburg, DE, Veronika-Pfaffenberger@hotmail.de
[2]UFPE, Recife, BR

Caatinga dry forests of Pernambuco, Brazil, have been transformed in many areas by land use practices such a grazing or irrigation farming, where water is available. Many farmers rely on cash crops of which coconut and banana are the most frequently grown in the area. The fields covered by these perennial crops often comprise a rich herb layer of predominantly native Caatinga species. In banana fields, farmers harvest every 15 days which implies intense use of fertilizers and plant protection measures such as herbicides and pesticides. In particular, banana requires high amounts of phosphorus, which is a limited resource and expensive for the farmers. Previous studies showed that plant diversity can influence yield through complementary plant-plant interactions which may enhance nutrient cycling and use efficiency within plant communities. In this study, we aimed to analyze if weeds, despite their short life cycle of maximum 60 days, influence the phosphorus nutrition of banana plants. For this, we related indices of species and functional diversity of the herb layer to different concepts of phosphorus use efficiency in banana. We hypothesize that functional diversity plays a more pronounced role for plant nutrition than species diversity. The results will allow for a better understanding of nutrient cycling in agroecosystems and of the ecosystem services provided by plant diversity.

P18 - Modelling the vertical and horizontal migration of wireworms: how does timing and intensity of root herbivore pressure impact grassland communities?

Cédric Scherer[1], Ilja Sonnemann[2], Susanne Wurst[2], Florian Jeltsch[1,3,4]

[1]University of Potsdam, Potsdam, DE, pscherer@uni-potsdam.de
[2]Freie Universität Berlin, Berlin, DE
[3]Leibniz Centre for Agricultural Landscape Research – ZALF, Müncheberg, DE
[4]Berlin-Brandenburg Institute of Advanced Biodiversity Research – BBIB, Berlin, DE

Click beetle larvae of the genus Agriotes (Coleoptera: Elateridae) are dominant generalist root herbivores in European grasslands and an important pest of a wide variety of crops. The damaging phases depend on soil temperature and soil moisture. As a result of unfavorable conditions in the upper soil layers (e.g. drought or frost) the mobile larvae perform vertical migration. Horizontal migration is believed to take place in search of food.

We developed a dynamic population-level simulation model describing the migration and dynamics of *Agriotes spp.* (*A. obscures, A. lineatus, A. sputator*). Making use of the available biological and ecological information, the model simulates key life stages of the relevant *Agriotes spp.* in a dynamic difference equation population model approach. We model dynamical changes in the abundance of these key Agriotes species in the Biodiversity Exploratory sites related to environmental conditions (i.e. temperature, rainfall, soil type). Environmental drivers and land use (i.e. vegetation cover and composition, evapotranspiration, root abundance) are used to simulate soil moisture conditions, soil temperature and food availability. Abiotic drivers as soil moisture and temperature have an influence on vertical migration between the soil layers, while the availability of roots as food resource impacts horizontal migration. By coupling this root herbivore model with an existing individual- and trait-based grassland community model (IBC-Grass), we aim to estimate the herbivore pressure on different plant functional types and the impacts on plant diversity.

P19 - The impact of land use on extraradical mycorrhizal mycelium (EMM) production and community composition

Abdallah Awad[2], Rodica Pena[2]

[2]George-August university , Forest Botany and Tree Physiology department, Göttingen 37077, DE, aawad@gwdge.de

Root symbiosis with mycorrhizal fungi is one of the main plant strategies to improve nutrient uptake. Mycorrhizal fungi increase the foraging area of the tree roots by producing a dense hyphal net that spread in the soil. According to the distance that the hyphae extend from the colonized root tips in the surrounding soil, presence or absence of rhizomorphs, and the branching structure, four extraradical mycorrhizal mycelium (EMM) exploration types have been identified (contact-distance, short-distance, medium-distance smooth, medium-distance mat, medium-distance fringe, and long-distance). The exploration types are considered as functional traits among EMF species in regard to the nutrient acquisition. In this study, we aim to investigate the impact of the forest management intensities on the EMM production and the community composition. The forest management practices enhance light intensity, which is a key factor of photosynthesis generating a higher plant C availability. We hypothesized that the EMM biomass will increase with the forest management intensity. To test this hypothesis, hyphal ingrowth meshbags filled with site-specific soil and surrounded by a sand barrier that prevent the saprotrophic hyphal ingrowth, were incubated for one vegetation period in the topsoil of forest stands along a gradient of forest management intensities. The study was done in the Biodiversity Exploratories priority program. The biomass of EMM was estimated by measuring the ergosterol soil content, as a biomarker for fungi, and by using the hyphal length measuring technique.

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P20 - The positive effects of tree species richness on fine root productivity

Zhen-Kai Sun[1]

[1]State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, The Chinese Academy of Sciences, Beijing, CN, sunzhenkai@ibcas.ac.cn

Tree species diversity has been reported to increase above-ground productivity, but how diversity affects fine root productivity and related mechanisms remain unclear. Here we used data from a large manipulated forest experiment (BEF-China) with trees of 5 years old to examine the effects of species richness on fine root productivity (measured as biomass and annual production) and distribution. We hypothysized that: (i) fine root productivity would increase with species richness and (ii) this relationship may be the result of niche differentiation among species with different root and rooting traits in mixtures. We found significantly non-linear and linear relationship between species richness and fine root biomass and production, respectively. And there were significant differences among species in fine root traits, such as diameter, specific root length and root depth. Therefore, reduced intra-specific competition and more complete resource use would be expected in mixtures for niche differentiation. However, there was significant over-yielding at only one higher richness level for both fine root biomass and production. Moreover, fine root vertical heterogeneities were negatively correlated with species richness and had a tight connection with fine root biomass and production. In conclusion, our study shows the positive effects of species richness on fine root productivity for reduced intra-speciefic competition and increased soil volume filling. But not all the richness level showed over-yielding which needs being further studied.

P21 - Indigenous impact on genetic diversity of Spondias tuberosa Arruda in NO-Brazil

Jannis Till Feigs[1], Deborah Silva de Oliveira[2], Barbara Rudolph[3], Arne Cierjacks[1]

[1]Universität Hamburg/ Biodiversität der Nutzpflanzen, Hamburg, DE, jtfeix@mail.de
[2]UFPE/ Universidade Federal de Pernambuco, Recife, BR
[3]Universität Hamburg/ Biodiversität, Evolution und Ökologie, Hamburg, DE

Umbuzeiro (*Spondias tuberosa* Arruda (Anacardiaceae)) is an endemic plant species of the Brazilian Caatinga dry forest. It is a multi-purpose tree with special adaptions (Xylopodium) to drought which makes it valuable both for man and animal. Albeit it's high cultural value, this species shows a pronounced lack in regeneration in the field which may be caused by genetic effects and leads to a high risk of extinction of this species. In this study, we compared the population genetics of *S. tuberosa* individuals growing in areas with a long land-use history by the indigenous tribe Pankararu since about 4000 BC, with trees of areas used for about 400 years and of areas recently transformed into irrigation farming schemes in 1980. Furthermore, we included areas without any land use. The study was conducted in Itaparica reservoir (Pernambuco; Brazil) as a part of the project INNOVATE. This region is particularly suited for this analysis as we find a model situation characterized by potential anthropogenic fingerprinting in plant population genetics on different time scales. We carried out AFLP analysis of two generations (leaf and bark material from adult trees and embryos extracted from seeds) to elucidate recent changes in the population genetics of *S. tuberosa*. We hypothesize that indigenous land use increased the genetic diversity in the species and that present-day genetic diversity is lower compared to the adult generation. The results of our study aim at contributing to improved conservation of this endangered fruit tree which represents a relevant genetic resource of the study region.

P22 - The influence of plant cultivar diversity and functionally dissimilar soil organisms on ecosystem functions

Xiaohui Guo2, Jana Petermann2,3,4, Conrad Schittko2, Susanne Wurst2,3

[2]Institute of Biology, Freie Universität Berlin, Berlin, DE, xiaohui.guo@fu-berlin.de
[3]Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), Berlin, DE
[4]Department of Ecology and Evolution, University of Salzburg, Salzburg, AT

Plant diversity and soil organisms are both widely studied for their contributions to ecosystem functions. However, intraspecific diversity as a potentially important part of plant diversity has so far received very little attention. To improve the understanding of how ecosystems functions may be influenced by intraspecific diversity, soil organisms, and their interactions, we examined in a natural field setting the individual and combinedeffects of plant cultivar diversity and soil organisms (manipulated by the addition of earthworms, arbuscular mycorrhizal fungi, and root knot nematodes) on the ecosystem functions aboveground primary production and pollination. Using clover-grass community we found a positive plant cultivar diversity – productivity relationship mediated by root knot nematodes, i.e. aboveground primary production was increased by cultivar diversity only in the nematode addition treatment. No effects of earthworms and AMF addition on aboveground primary production were detected. Pollinator abundance was increased by plant cultivar diversity, and floral visitation length was decreased earthworm addition. Leaf damage of *Trifolium pratense* was marginally influenced by the interaction between the earthworm and nematode addition treatment. We conclude that plant cultivar diversity and soil organisms can interactively or independently modify functions such as aboveground primary production and pollination in the field.

P23 - Land use, biodiversity and ecosystem services on vineyard areas, mainly in conurbations

Siegmar Thomas[1]

[1]Dresden University of Technology, Dresden, DE, siegmar.thomas@mailbox.tu-dresden.de

Assessments, goals and measures of intensive agriculture and species protection after „Artenschutz-Report 2015. Tiere und Pflanzen in Deutschland. Ed.: Bundesamt für Naturschutz, Bonn“ will be compared with small vineyard areas mainly at the right side Elbe river slopes from the West-Lusation granite plateau inside cities of

Saxony from Pirna in the South to Dresden and to Meißen in the North.

The high biodiversity, also with rare species (tables are given), of the pre-industrial vineyards is reduced in areas with strong herbicide use, high fertilizer, e.g. nitrogen use, and in conjunction with modern „industry standards“ for agricultural technolgy. The results are species poor steppe-like vine sites. This can affect optimal ecosystem services negatively and restricting (through increased soil, water, air pollution, mainly through plots in the vicinity of residential areas; wind and water erosion; pollution with pesticides; reducing spatial biodiversity, etc.). On-site effects and spacious effect fields of ecosystem services are linked to the physical geography and land use patterns, and are modified by them and act on them in a variety of ways. The spatial effect fields can extend far beyond administrative boundaries and land use units (surface water and groundwater currents of the river basins, atmospheric flow fields, soil movement paths ...). Level out the natural terrain relief causes reduction of spatial biodiversity ("Modern Landscaping" or intervention in nature and landscape?). Clearing of (remaining) forests, groves in favor of agricultural crops may have adverse effects on urban climate (warmer and drier steppe climate, stronger cold air and storm exposure). Urban landscape planning can help to protect largely ecosystem services and spatial biodiversity (safe distances; forest belts; hedgerows; trees; groves; principles of "agroforestry" to get more landscape heterogeneity and linked biotopes, more carbon fixation and erosion control. Protected Landscape and Nature Areas are important.

P24 - Management concept for Central European vineyard ecosystems: Promoting ecosystem services in grapes

Martin Pingel[1], Deniz Uzman[1], Annette Reineke[1], Ilona Leyer[1]

[1]Hochschule Geisenheim University, Geisenheim, DE, martin.pingel@hs-gm.de

The interaction between biodiversity and ecosystem services (ESS) is recognised to play a key role in the context of sustainable agricultural systems requiring as few external inputs as possible. Cultivation of grapevine as a perennial crop has a high potential of providing ESS linked to biodiversity since viticulture does not aim at producing maximum yield but rather high quality products. Additionally, viticulture canprovide high levels of biodiversity inside the cropped area, which cannot be found in annual cropping systems. Thus, viticultural systems provide ideal conditions for analysing biodiversity and ESS relevant for the vine grower such as soil fertility, water retention, pest control as well as grape quality.

Our research is part of a European project carried out in temperate vine-growing regions in five countries. The major aim is to identify management options for promoting biodiversity linked ESS in temperate Europe vineyard ecosystems. In particular, the project focuses on soil biodiversity, as interactions between the diverse soil biota as well as chemical and physical properties of the soil environment are fundamental for the provision of soil-based ESS.

In a common study with all countries involved we analyse the links between diversity of soil relevant species groups (soil microflora including mycorrhiza, mesofauna, macrofauna, plants), soil function, and respective ESS. Management effects are analysed at two different scales covering the factor ground management inside the vineyards with three different disturbance levels and the factor landscape heterogeneity surrounding the vineyards.

Additional studies focusing on different levels of nitrogen fertilization, and farming type (integrated, organic) will further promote knowledge on biodiversity-ESS relationships in order to improve management concepts in temperate viticultural systems.

P25 - Modelling effects of variable herbicide exposure to herbaceous field boundary communities

Jette Reeg[1], Thorsten Schad[2], Andreas Solga[2], Thomas G Preuss[2], Katrin Körner[1], Florian Jeltsch[1]

[1]Universität Potsdam, Potsdam, DE, j.reeg@uni-potsdam.de
[2]Bayer CropScience, Monheim, DE

Conventional farming increased in the last decades and with it the widespread use of herbicides. Herbicides, as they drift into neighboring areas, can affect non-target plant communities. The European Food and Safety Authority published an opinion in 2010 claiming the necessity to not only consider direct impacts of herbicides on plant individuals and populations but also demanding to test for potential effects emerging from inter- and intraspecific interactions, i.e. community-level endpoints such as diversity, structure and composition (Specific Protection Goals).

We linked a spatiotemporally explicit drift exposure model (Xplicit) to an individual-based grassland community model (IBC-grass). Thereby we analyzed impacts of herbicide drift on structure and composition of non-target plant communities. Based on an extensive literature review of herbaceous field boundaries in Europe, a representative field-edge community of perennial plant species was derived and parameterized into the trait-based approach of IBC-grass. Variable herbicide exposure and its impact on individual-level was calculated with Xplicit and species effect distributions were generated. These individual-level effects were transferred to individuals of plants, seedlings and seeds within IBC-grass in order to simulate community effects of realistic herbicide drift events.

Short-term as well as long-term effects of herbicide exposure on the structure and composition of the plant communities were closely linked to distance to field edge. The greater the distance, the smaller the effects.

The mechanistic modelling approach indicates that the species composition and abundance within field boundaries can be impacted by agricultural practices such as herbicide applications. Modelling approaches such as IBC-grass can be useful tools to evaluate the importance of assessing community-level endpoints in real-world context in ecological risk characterizations.

P26- Resilience of agricultural systems to biological invasion

Chloe MacLaren[1], Katharina Dehnen-Schmutz[1], James Bennett[1], Julia Wright[1]

[1]Centre for Agroecology, Water and Resilience; Coventry University, Coventry, UK, chloe-maclaren@gmail.com

Ecosystem resilience refers to the capacity of ecosystems to absorb change and disturbance whilst still retaining their essential relationships, structure and function. Here we explore resilience and vulnerability in agricultural systems to invasions by non-native plant species, through investigating how the ecology of invaders and invasibility applies to agricultural systems. Silverleaf nightshade *(Solanum eleagnifolium),* a serious pest in agricultural systems throughout many dryland regions of the world, provides a case study to examine how invader traits and agroecosystem dynamics affect invasiveness and invasibility. We also explore how resilience to plant invasions (in particular *S. eleagnifolium)* varies along a gradient of increasing farm intensification, and examine which factors contribute to this variation. Our research seeks to identify improvements in agroecological weed management, as invasive weeds such as *S. eleagnifolium* can have serious impacts on farm yields, and many farmers perceive weed control as a barrier to converting to more environmentally-friendly farming systems.

P27 - Species diversity governs the spread of pesticide resistance

Jeremias Becker[1,2], Neeraja Venkataraman[1], Nicole Sanwald[1], Matthias Liess[1,2]

[1]Dept. System Ecotoxicology, Helmholtz Centre for Environmental Research GmbH - UFZ, Leipzig, DE, jeremias.becker@ufz.de
[2]Dept. Ecosystem Analysis, Institute for Environmental Research, RWTH — Aachen University, Aachen, DE, jeremias.becker@ufz.de

Agricultural pests and pathogen vectors have rapidly evolved high levels of pesticide resistance. In contrast, most aquatic non-target species have developed only slightly increased resistance to pesticides from agricultural run-off. This has been demonstrated for limnic macroinvertebrates from central Germany. We hypothesized that the contrasting potential for genetic adaptation to toxicants results from different competitive conditions in both groups.

Resistant individuals typically experience fitness costs in a non-toxic environment. In contrast, after a pulse exposure to pesticides the surviving susceptible individuals experience fitness costs. Additional environmental stressors increase such fitness costs and foster both the spread of pesticide resistance and the genetic recovery of a resistant population when pesticide treatments have stopped.

As demonstrated in the mosquito *Culex quinquefasciatus*, interphenotypic competition between susceptible and resistant individuals is a particularly important driver of microevolution. This is because the adapted phenotype outcompetes the non-adapted phenotype. When interphenotypic competition was reduced through predation or replaced by interspecific competition with the water flea *Daphnia magna*, the fitness contrast between susceptible and resistant mosquito larvae decreased and microevolution was delayed.

We conclude that in diverse aquatic communities, species interactions can limit the potential for the spread of pesticide resistance. In contrast, high levels of intraspecific competition foster the spread of resistance in simplified communities such as monocultures and mosquito breeding sites. Strategies for an integrated pest control should recognize this ecosystem service of species diversity for resistance management.

P28 - What comes after the storm? Impacts and responses 25 years after Vivian and Wiebke in an unmanaged and a comparable managed forest stand

Michelle Sundermann[1], Peter Meyer[1], Marcus Schmidt[1]

[1]Northwest German Forest Research Station, Göttingen, DE, michelle.sundermann@nw-fva.de

The Natural Forest Reserve (NFR) “Weiherskopf” is situated southeastern of the middle mountain range of the Vogelsberg Region in the Federal State of Hessen. It was legislated in 1988 and at that time characterized by a 100 year old forest stand with mainly beech and other hardwood species. The Hessian approach for natural forest research include for the most NFR an unmanaged area (here: 53 hectares) and a comparable managed reference area (here: 35 hectares).

In the early 1990ies the storms Vivian and Wiebke threw a total of 23 hectares in the unmanaged Weiherskopf area and another 10 hectares in the managed reference area. This calamity was quickly identified as an exceptional chance to observe impacts and responses of storm disturbances in these contrarily treated forest stands. Consequently, the windblown wood remained in the unmanaged but was processed in the managed area. Both forest stands were thereafter reforested by natural regeneration.

The comprehensive research program was carried out and coordinated by the Northwest German Forest Research Station between 2013 and 2014 with the objective to analyze the effect of forest management. As indicators serve forest structure and species diversity of vegetation, mosses and lichens, land snails and saprophytic beetles.

Some of the main findings are: until today both areas show distinct and statistically significant differences in the amount of dead wood. However, the growing stock of the following generation, characterized by tree species composition, stand density and total volume is mainly comparable. Species richness of ground and shrub layer as well as of beetles is higher in the managed forest stand than in the unmanaged area. The results for land snails are equal in both areas.

The long term expectation for the unmanaged area though is a positive and sustainable effect for biodiversity.

P29 - Crop Diversity and Income Stability on Farms inBavaria: Composition of Portfolios Is More Crucial thanPure Quantity of Crops

Robert Weigel[1,2], Christina Bogner[1], Thomas Koellner[2]

[1]Professorship of Ecological Modelling, Faculty of Biology, Chemistry and Geosciences, BayCEER, Bayreuth, DE, robert.weigel@geoecology.org
[2]Professorship of Ecological Services (PES), Faculty of Biology, Chemistry and Geosciences, BayCEER, University of Bayreuth, Bayreuth, DE, robert.weigel@geoecology.org

The stability of agricultural productivity is important for economic success at farm level. Portfolio theory applied on arable land, i.e. scattering of risks by a diverse crop portfolio, can mitigate risks for farm income. However, this topic was previously rather addressed in developing countries, although mitigating income risk is also increasingly important in industrialized EU member states due to decreasing market support and coupled direct payments in the EU Common Agricultural Policy. Therefore, it was hypothesized that portfolio diversity mitigates risk regarding yield and income in industrialized regions, such as Bavaria as a state of Germany. A further hypothesis was that farm characteristics (part-time farming, farm type, whole farm revenue, farm size, organic farming) could explain the choice of portfolios with regard to risk reduction. Clustering for large applications was applied to detect typically cultivated portfolios within the Bavarian agricultural census ($N=79\,532$). Time series of yield and revenue were decomposed in trend, multiannual components, and short-term variability using singular spectrum analysis. The relationship of farm characteristics and choice of risk reducing portfolios was analysed with random forest analysis. The diversification of portfolios mitigated yield failure and income risk in the long term, but this effect was less pronounced in recent years and might fail during a widespread collapse of agricultural prices. Farm characteristics such as whole farm income, farm type, farm size, and location explained portfolio choice, but were hardly linked to stability decisions. The results indicated that farmers can potentially profit from portfolio effects, but occasionally high market prices for few specific crops will favour agricultural intensification and simplified portfolios. Temporal dynamic and regionally custom agro-environmental schemes should be considered to counteract these situations to maintain diversity in agriculture. This might help to provide benefits of ecosystem services for farmers as well as for the public.

P30 - Yield and nutrient content of short rotation coppice on marginal sites: former sewage farms, waterlogged grassland, and inundated cropland

Nora Koim[1], Dieter Murach[1]

[1]Eberswalde University for Sustainable Development, Eberswalde, DE, nora.koim@hnee.de

Field and experimental trials with short rotation coppice (SRC) of poplar and willow were conducted on selected marginal sites recurrent in the federal state of Brandenburg in northeast Germany. These sites are not suitable for food production (due to contamination on former sewage farms) or annual cultures (due to water excess on waterlogged or regularly inundated sites). The research motive therefore was to determine if short rotation coppice offer a valid option for land use under these special site conditions, investigating opportunities and constraints in yield and cultivation, and analyzing leaf and wood nutrient contents. Results after the first rotation period of three to four years show that (a) on former sewage farms rods perform more reliably than short cuttings in terms of yield and survival, (b) on waterlogged grassland poplar is more susceptible to waterlogging than willow if critical groundwater levels are permanently exceeded, (c) nevertheless also poplar may tolerate prolonged periods of water excess on inundated cropland if soil and water chemistry are suitable, and (d) even at a juvenile age poplar and willow varieties tolerate inundation. On former sewage farms the greatest challenge is a careful site selection prior to planting as contamination levels are highly variable even on small scales. Variance in yield and vitality is consequently greater than in conventional SRC. On waterlogged sites, performance of willow was positive, offering an interesting land use alternative for areas adjacent to bogs, which are widely spread in northeast Germany. Establishing willow SRC on these lots would allow income generation for the farmer while re-wetting neighboring bogs to preserve peat carbon storage, which under current conditions are undergoing mineralization through drainage for agriculture.

P31 - Sustainable land management in the North Germain Plain: A scenario analysis

Robert Nuske[1], Hermann Spellmann[1], Georg Leefken[1], Inge Kehr[1]

[1]NW-FVA, Göttingen, DE

Sustainable land management cannot longer be considered and developed without taking influences of global change and markets into account. Those challenges strongly affect opportunities and risks asking for adaptation and, if necessary, further reorientation of the land management.

The study relies on a transdisciplinary analysis of main land use systems (forestry, agriculture and water management) and their interactions. Nature conservation is considered an integral part of these management forms. The intensive integration of research and regional stakeholders shall help to gain additional knowledge, to quicken development of overall concepts, and to come up with effective adaptation measures.

A model driven scenario analysis was conducted for the period 1991-2070. Three scenarios describing possible societal developments were formulated. The "business as usual" scenario is accompanied by the contrasting scenarios putting "biodiversity" or "climate mitigation" first. The main land use systems and their interactions are represented by a range of statistical and process models driven by climate (RCP 8.5) and market changes (CAPRI).

The rural areas in Germany differ in their sensitivity and adaptability to climate change. Hence four model regions, on a west-east gradient within the "North German Plain", were examined exemplary. Results are compiled in a trans-sectoral indicator system. They show, amongst others, that agriculture has to adapt to drier conditions during the vegetation period but will likely experience a yield increase. Whereas forestry, bound by dominantly young stands in the model regions, can react only slowly and has to plan ahead for long periods. Based on the scenario analysis the project developed a knowledge and decision basis for a sustainable land management in the North German Plain against the background of climate change and increasingly globalized markets.

P32 - The ecological role of landscape structure in agricultural landscapes of Japan and Germany: a comparative approach based on common indicators

Keiko Sasaki[1], Stefan Hotes[2], Volkmar Wolters[1], Taku Kadoya[3], Akira Yoshioka[3], Birgit Aue[1], Fred Jopp[1]

[1]Justus Liebig University Giessen, Giessen, DE
[2]Philipps-University Marburg, Marburg, DE
[3]National Institute for Environmental Studies, Tsukuba, JP

Satoyama is the traditional rural landscape in Japan where diverse mosaics of agricultural and non-agricultural land (e.g. forest, rice paddy field, grassland, streams, ponds, and reservoirs for irrigation) coexist in a small-scaled socio-ecological system. Management of such diverse land-use types, whether individually or in a certain spatial context, is considered to provide a variety of habitats for wildlife and thus to play an important role in biodiversity conservation in Japan. Similarly, measures for biodiversity conservation in cultural landscapes in Europe aim to maintain or increase the proportion of semi-natural habitats to enhance habitat heterogeneity. In our study, we hypothesized that general landscape structure – biodiversity relationships exist irrespective of climatic, biogeographical, and social-economic background. Using Japan and Germany as case studies, we first aim to quantify landscape structure of these two countries using the 'Satoyama Index' (a habitat diversity index developed to capture relevant features for biodiversity) and other commonly used landscape indices, and to describe differences and similarities of the agricultural landscapes in both countries. The overarching goals are to examine how indicator species with similar ecological niche respond to these common indices, and to investigate the feasibility of indicator-based approaches to the management of agricultural ecosystems.

P33 - Vegetation history and dynamics of the forest-steppe-biome in the Mongolian Altai

Andreas Laug[1], Hermann Behling[1], Choimaa Dulamsuren[1], Gaadan Punsalpaamuu[2]

[1]Georg-August Universität Göttingen, Göttingen, DE, andreas.laug@gmx.de
[2]National University of Mongolia, Ulaanbaatar, MN

This study focuses on the history and development of the forest belt between steppe and alpine grasslands in the Mongolian Altai during the Late Holocene. Palynological analyses are used to examine a sediment core from alpine grasslands above Lake Dayan Nuur (2484 m asl.). The results form the basis of a better understanding of the variability and dynamics of today's forest-steppe-ecosystems and their biodiversity. Furthermore the palynological approach gives insights into position and composition of the *Larix sibirica* forest belt for a longer period of time than any previous studies.

P34 - Ectomycorrhizal identification in environmental samples of tree roots by Fourier-transform infrared (FTIR) spectroscopy

Nan Yang[1], Andrea Polle[1], Rodica Pena[1]

[1]Georg-August-University of Göttingen, Department of Forest Botany and Tree Physiology, Goettingen, DE

Beech (*Fagus sylvatica*) roots are colonized by ectomycorrhizal (EM) fungi that play a key role in ecosystem nutrient cycling by influencing both organic matter decomposition and plant nutrient uptake. Fourier transform infrared (FTIR) spectroscopy is a well-established tool for fingerprinting the chemical profile of biological samples. Recently, FTIR combined with multivariate statistical analysis was employed to distinguish and identify EM taxa, which were collected in the field (Pena et al. 2014). However, EM fungal biochemical composition is influenced by external abiotic factors, and intrinsic fungal properties. In this study, we aim to disentangle the two components, and interrogate the FTIR spectra of the same EM taxa grown under field conditions that vary in soil input of organic residues. We hypothesized that individuals of the same fungal species grown in different soil microhabitats exhibit different chemical fingerprints that vary in distinct wavenumbers because fungal access to specificcarbon storages and nutrient sources. To test this hypothesis, beech seedlings were planted in the forest and treated for four years with leaf litterspecies from either*Fraxinus excelsior, Fagus sylvatica, Tilia cordata,* or*Acer pseudoplatanus*, a mixture of the litter from these species, and no leaf litter. Samples of root tips colonized by four different EM taxa (*Cenococcum geophilum*, *Lactarius subdulcis*, *Tomentella* sp., *Tuber* sp.), and three vertical delimited soil fractions were measured by FTIR spectroscopy.

We are grateful to the Ministry for Science and Culture of Lower Saxony and VW Vorab for funding the Cluster of Excellence Functional Biodiversity Research and to the CSC for providing a PhD scholarship to Nan Yang.

[1] Pena R., Lang C., Naumann A., Polle A. 2014. Ectomycorrhizal identification in environmental samples of tree roots by Fourier-transform infrared (FTIR) spectroscopy. Front. Plant Sci.5: 229.

END OF SESSION 13

Session 14 - Models and model systems for understanding (meta-) community dynamics

Short title: Understanding community dynamics

CHAIRS: DR. EMANUEL FRONHOFER, DR. FRANK PENNEKAMP, DR. MIKAEL PONTARP

O1 - Eco-evolutionary dynamics in plankton communities

Lutz Becks[1], Elias Ehrlich[2], Noemi Woltermann[1], Ursula Gaedke[2]

[1]Community Dynamics, Max-Planck Institute for Evolutionary Biology, Ploen, DE, lbecks@evolbio.mpg.de
[2]Institute of Biochemistry and Biology, University Potsdam, Potsdam, DE

Although the patterns and processes that underlie population and community dynamics have been studied extensively over the past decades, we still do not fully understand what general mechanisms drive the dynamics observed in nature. Understanding those mechanisms, however, is essential for successful conservation attempts in our rapidly changing world facing decreasing biodiversity, habitat degradation and the effects of climate change. It is increasingly apparent that variation in functional traits within and across populations plays an important role in determining population and community dynamics, and hence their long-term stability. Population dynamics in turn may change the direction and strength of selection and thus alter frequencies of genotypes best adapted to the altered ecological conditions, e.g. high densities of a predator or scarce nutrients. Predator-prey cycles have, for example, been identified as a "driver" of ongoing evolution, selecting for a costly defence trait in the prey at high predator densities and against it during times of low predation pressure. This entanglement of changes in the prey's trait and the predator and prey population sizes, all within a few generations, results often in so-called eco-evolutionary feedback. The study of eco-evolutionary feedback dynamics has greatly benefited from theoretical modelling and experimental approaches and we will present results from experiments and models where we compared the evolutionary and ecological dynamics of experiments with a planktonic predator-prey system. Specifically, we will present results from studies testing for the role of the shape of the preys‘ trade-off between being defended and competitive. We show that the shape of the trade-off (linear, concave, convex as well as the range) is highly important for eco-evolutionary dynamics.

O2 - The use and potential of protist microcosm experiments to study spatial community ecology

Florian Altermatt[1,2], Emanuel Fronhofer[1], Aurélie Garnier[2], Andrea Giometto[1], Frederik Hammes[1], Jan Klecka[1], Delphine Legrand[3], Thomas Massie[2], Elvira Mächler[1], Frank Pennekamp[2], Owen Petchey[2], Marco Plebani[2], Mikael Pontarp[2], Nicolas Schtickzelle[3], Mathew Seymour[1], Virginie Thuillier[3]

[1]Eawag Aquatic Ecology, Dübendorf, CH, florian.altermatt@eawag.ch
[2]University of Zurich, Zurich, CH, florian.altermatt@eawag.ch
[3]Université catholique de Louvain, Louvain-la-Neuve, BE

A major current challenge in ecology is to causally link processes and patterns across various levels of complexity. An extensive body of theoretical work has been developed but a major challenge is to link theoretical concepts with empirical data from natural study systems. Often, natural study systems do not allow the replication and control needed to validate model assumptions and to test model predictions, as spatial and temporal scales are too large, and experiments logistically or ethically prohibitive. Experimental microcosms using protists as model organisms, reflecting “small worlds”, offer a unique possibility to test general concepts in ecology. Many variables of interest can be measured in order to study processes and patterns at different spatiotemporal scales and across all levels of biological organization. This includes measurements of body size, mobility, or abundance, in order to understand population dynamics, dispersal behaviour, and ecosystem processes. I will give an overview of methods commonly available to do protist microcosm experiments, enabling the standardization of experiments needed for meta-analyses or distributed experiments. I will use the example of dendritic riverine networks to show how effects of spatial connectivity structure and local environmental factors structuring community composition and diversity can be disentangled experimentally. Specifically, we found that community diversity patterns were shaped by the interaction of dispersal within dendritic networks and local species interactions, identifying possible implications for the management of natural riverine ecosystems.

O3 - Informed dispersal in metacommunities

Emanuel A. Fronhofer[1,2], Jan Klecka[3], Tabea Kropf[4], Carlos J. Melián[1], Florian Altermatt[1,2]

[1]Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, CH, emanuel.fronhofer@eawag.ch
[2]University of Zurich, Zurich, CH, emanuel.fronhofer@eawag.ch
[3]Biology Centre of the Czech Academy of Sciences, České Budějovice, CZ
[4]ETH Zurich, Zurich, CH

Dispersal, and the underlying movement behaviour, are processes of pivotal importance for understanding and predicting metapopulation and metacommunity

dynamics. Generally, dispersal decisions are non-random and rely on information, such as the presence of conspecifics. However, studies on metacommunities that include interspecific interactions generally disregard information use. Therefore, it remains unclear whether and how dispersal in metacommunities is informed and whether rules derived from single-species contexts can be scaled up to (meta-) communities.

Firstly, using microcosm experiments with the ciliate model organism Tetrahymena we present evidence for the shape of the density-dependent dispersal and movement function in a single-species setting. Movement strategies in *Tetrahymena* were plastic and density-dependent. The observed movement reaction norm was u-shaped which is likely due to an Allee effect. This adaptive density-dependent movement strategy was mediated by chemical cues.

Secondly, using experimental protist metacommunities, we show how dispersal and movement are informed and adjusted by the strength of inter-specific interactions. We found that predicting informed movement and dispersal in metacommunities requires knowledge on behavioural responses to intra- and inter-specific interaction strength.

Consequently, metacommunity dynamics inferred directly from single-species metapopulations without taking inter-specific interactions into account are likely flawed. Our work identifies the significance of information use for understanding metacommunity dynamics, stability and the coexistence and distribution of species.

O4 - Estimating functional responses - a good fit for a good community model

Björn C. Rall[1,2,3,4]

[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE, bjoern.rall@idiv.de
[2]Institute of Ecology, Friedrich Schiller University Jena, Jena, DE, bjoern.rall@idiv.de
[3]Department of Aquatic Ecology & Department of Terrestrial Ecology, Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, NL, bjoern.rall@idiv.de
[4]J.F. Blumenbach Institute of Zoology and Anthropology, Georg-August-University Göttingen, Göttingen, DE

Feeding interactions are the energetic backbone for all multi-trophic community models (i.e. food-web models) determining their stability. These interactions are described by functional responses and are used in all environmental sciences ranging from marine to terrestrial, and from fundamental to applied sciences. Communities with a type II functional response are less stable than communities with type III functional responses. In consequence, to set up reliable community models we need exact measurements of the type of functional responses. Estimating functional response parameters based on empirical data is not trivial as prey density decreases through time. Consequently, the independent variable changes with progressing time of the experiment. To overcome this issue, the standard procedure is to use the analytical integration of the type II functional response, accounting for resource depletion over time. Using this approach for analysing type III functional responses may lead to a bias in the parameter estimation.

Here, I employed model simulations mimicking functional response experiments to test the quality of different existing statistical approaches. Further, I developed an alternative method using the numerical integration of the functional response, independent of the type. All three methods yield the exact same quality of parameter estimation as long the classical type II functional response is used. When estimating the parameters of the type III functional response the newly developed numerical integration method out-competes the former in quality. More precisely, the attack rate is underestimated by the traditional methods that may lead to a overestimation in stability of community models. Additionally, my method is easily adaptable to any other functional response model, e.g. to incorporate multiple prey or prey growth as co-variable.

O5 - Patch heterogeneity affects interaction strength and dynamics of meta-community

Yuanheng Li[1], Björn C. Rall[1], Ulrich Brose[1]

[1]Deutsches Zentrum für integrative Biodiversitätsforschung (iDiv) Halle-Jena-Leipzig, Leipzig, DE, yuanheng.li@idiv.de

Intensive human activities like land use change and overexploitation greatly changed natural habitats, causing habitat loss and fragmentation. Therefore it is crucial to understand how changes in habitat structures and size affect dynamics and functioning of ecosystems. These properties are driven by feeding interaction strength suggesting that it is important to understand how feeding interactions scale with changes in habitat size and structure. The functional response framework is one possibility to measure interaction strength, moreover it is used mainly to set up multi-trophic community models. As measuring functional responses is extremely labor intensive, we use individual-based model to simulate functional responses, studying the effect of habitat size and habitat heterogeneity on the interaction strength. Our results show that habitat size has no significant effect but increasing habitat heterogeneity increases the half saturation density (i.e. the decrease in hunting efficiency of the predator).

Increasing the half saturation density generally stabilizes isolated (single patch) multi-trophic communities. Based on our individual based model results, we investigate how increase in habitat heterogeneity (increase of the half saturation density) influences the alpha- and gamma-dynamics of a multi-trophic meta-community model.

O6 - Combining models and data to understand the consequences of animal pollination for plant community dynamics

Helen Czioska[1], Gita Benadi[1]

[1]University of Freiburg, Freiburg im Breisgau, DE

How the average reproductive success of a species changes with its frequency in the community may have far-ranging consequences for the maintenance or loss of species diversity. Whereas a negative relationship between frequency and reproductive success tends to promote diversity by allowing each species to recover from low density, positive frequency dependence has the tendency to lead to species loss. For plant-pollinator interactions, optimal foraging theory predicts that flower visitors should preferentially visit the most common flower type. If reproductive success is proportional to visitation rate, this implies that pollination by animals decreases diversity by giving abundant plant species an advantage over rarer ones. However, both positive and negative frequency dependence have been found in the few empirical studies conducted to date, which suggests that the effects of animal pollination may be more complex than theory predicts.

Here, we present results of a pilot study on frequency dependence of flower visitation rates of five plant species grown in a longterm biodiversity experiment. We compare these data to an individual-based model of foraging pollinators designed to test how the shape of the frequency-visitation rate curve changes depending on environmental conditions and parameters related to pollinator behaviour. Under most conditions, our model shows a cubic relationship between plant frequency and visitation rate, in accordance with the empirical data of four of five plant species. Moreover, the model's predictions suggest that floral cover, the degree of clustering of conspecific plants and the rate of floral nectar repletion are important factors which influence the shape of the frequency dependence curve. These results may help to explain contrasting findings of empirical studies on frequency dependence of pollination and increase our understanding of the consequences of biotic pollination for plant community dynamics.

O7 - Models and experiments for advancing ecological predictability research

Owen Petchey[1]

[1]University of Zurich, Zurich, CH, owen.petchey@ieu.uzh.ch

Forecasts of ecological dynamics in changing environments are increasingly important, and are available for a plethora of variables, such as species abundance and distribution, community structure, and ecosystem processes. There is, however, disagreement about whether ecological dynamics are predictable, and therefore whether researching ecological forecasting is worthwhile. I will show how combining of models and experimentation can play a key role in resolving this debate. Initial results suggest a resolution based on recognising and understanding scaling of ecological predictability, for example with organismal features such as body size, and with level of ecological organisation.

O8 - The Season-Diversity Relationship

Jarad Mellard[1], Michel Loreau[1]

[1]Center for Biodiversity Theory and Modelling, CNRS, Moulis, FR, jarad.mellard@ecoex-moulis.cnrs.fr

A conspicuous Species-Time Relationship can be seen in species diversity in seasonal environments. We hypothesize the relative balance of abiotic-limited growth (resources, temperature) and biotic-limited growth (interactions) determines the phenological strategy of different species and the resultant species diversity patterns. We assembled and analyzed empirical datasets on species diversity through time in seasonal environments. We conducted a modeling study in conjunction with this data analysis to replicate the seasonal patterns observed in the data. In our modeling, we compared alternative dynamical models to explain the patterns and selected the models that have support for the assumptions and match the patterns in the data. This model selection generated novel predictions about species niches and occurrences in time which we tested in the data allowing us to confirm and reject specific model predictions and general hypotheses. We identified key similarities and differences between terrestrial and aquatic habitats and taxa in what processes drive similar seasonal patterns in species diversity. We predict under what conditions we can expect to observe a pattern in species diversity and the general shape of that pattern, increasing our general understanding of ecological communities.

O9 - Metacommunity genetics in a terrestrial plant-insect system

Sharon Zytynska[1], Matthias Senft[1], Mary Clancy[2], Jörg-Peter Schnitzler[2], Wolfgang Weisser[1]

[1]TU München, Freising, DE, sharon.zytynska@tum.de
[2]Helmholtz Zentrum München, München, DE

Metacommunities are characterised by frequent extinction and colonisation events, which are driven by locally unstable but regionally stable predator-prey interactions and further exasperated by limited dispersal between patches. Current metacommunity theories are only weakly supported by empirical research, with the traditional paradigms often ignoring patch variation or host-preference effects. Plant-insect metacommunities are ideal model systems for studying metacommunity dynamics, with each individual host plant acting as a patch within a matrix of unsuitable habitat. This is particularly true for more specialised herbivores, where the range and spatial distribution of the host-plant will have a stronger effect on the metacommunity dynamics. An example of such a system are aphids specialising on the host plant tansy (*Tanacetum vulgare*), and their associated natural enemies. This plant species contains many essential oils, leading to a large variation in chemical profiles (chemotype) of the plants even within a single field site. Such variation in the plants can drive differences in aphid colony persistence directly through changes in aphid performance or preference, and indirectly by changing natural enemy abundance. We present data showing that phenotypic and chemical variation in the plant can influence aphid colony growth and persistence. In addition, we found that plant variation can mediate interactions between the aphids and other interacting species, such as ants and predators. We discuss the bottom-up effects of plant chemotype, and top-down effects of natural enemies, on aphid population dynamics and genetics in this metacommunity system.

O10 - The role of within-host competition for coexistence in multiparasitoid-host systems

Ellen van Velzen[1,2], Saleta Pérez-Vila[2], Rampal Etienne[2]

[1]University of Potsdam, Potsdam, DE, velzen@uni-potsdam.de
[2]University of Groningen, Groningen, NL, velzen@uni-potsdam.de

Multiparasitism (females of multiple species parasitizing the same host) is a ubiquitous phenomenon in parasitoids, yet the effect of within-host competition on coexistence has been mostly ignored in multiparasitoid-host models. Inspired by coexistence in a patchy multiparasitoid-host system (*Nasonia vitripennis* and *N. giraulti* coexisting on *Protocalliphora* spp. in birds' nests, despite strong host use overlap and *N. giraulti* being an inferior competitor), we construct a more realistic model explicitly incorporating larval competition. We test two possible hypotheses for persistence of an inferior competitor: lower within-host competition (a higher within-host carrying capacity) and asymmetric within-host competition (the inferior competitor having an advatage in larval competition). Surprisingly, while coexistence is reduced by strong between-adult competition (strong overlap in distribution over patches), it is promoted by stronger within-host competition (lower within-host carrying capacity). Asymmetric within-host competition can offset the competitive disadvantage of the inferior between-adult competitor, but only when within-host competition is strong and the correlation between the parasitoids' distributions is intermediate. We conclude that either low or asymmetric within-host competition are unlikely to explaincoexistence in this system. Additionally, we discuss our results in the context of coexistence in multiparasitoid-host systems in general.

O11 - The biogeography of adaptive radiations and the geographic overlap of sister species

Mikael Pontarp[1]

[1] University of Zurich, mikael.pontarp@biol.lu.se

The biogeography of speciation and what can be learned about the past mode of speciation from current biogeography of sister species are recurrent problems in evolution. We used a trait- and individual-based, eco-evolutionary model to simulate adaptive radiations and recorded the geographical overlap of species during and after evolutionary branching (speciation). We compared the spatial overlap among sister species in the fully saturated community with the overlap at the speciation event. The mean geographic overlap at speciation varied continuously from complete ('sympatry') to none ('allopatry') depending on local and regional environmental heterogeneity, and the rate of dispersal. The distribution of overlap was, however, in some cases considerably bimodal. This tendency was most expressed at large values of regional heterogeneity, corresponding to sharp environmental contrasts. The mean geographic overlap also varied during the course of a radiation, sometimes with a consistent negative trend over time. The speciations that resulted in currently observable end community sister species was therefore not an unbiased sample of all speciations throughout the radiation. Post-speciation range shifts (causing increased overlap) occurred most frequently when dispersal was high or when local habitat heterogeneity was low. Our results help us understand how the patterns of geographic mode of speciation emerge. We also show the difficulty in inferring the geographical speciation mode from phylogenies and the biogeography of extant species.

P1 - Modelling biological pest control: A case of study in Sugarcane

Rubens Gamaliel Bergamo de Souza[1], Donavan Peres Rodero[2], Alexandre Colato[2]

[1]São Carlos Federal University (UFSCar), São Carlos, BR, rubensgamaliel@hotmail.com
[2]São Carlos Federal University (UFSCar), Araras, BR

"Brazil is the world's largest sugarcane producer, accounting for over 50% of planted crops. However, from the sugarcane pest control studies, there are no mathematical models that describe interactions between pests and control methods validated with field data. We study a mathematical model to describe the interaction between the moth Diatraea saccharalis, major sugarcane pest, and its natural predator the wasp Cotesia flavipes.

A predator-prey model was considered, where the growth rate for the prey is given by $dN/dt=N(0.056-0.000025P)$ and for the wasp $dP/dt=P(0.0015N-1.2)$, with the parameters found in literature, which shows a stable equilibrium point, besides the trivial solution where extinction happens.

The main recommendation is that whenever 1000 moths are identified, 6000 predators must be used to get a satisfactory control. The model reveals a better set to control the pest, which is given by N=800 and P=2240, that generates less variation in the pest population size and lower costs for its control. However, this model has yet to be field tested to assess how close is its behavior in relation to the real situation.

There is somewhat a difficulty to find field data to prove the model is right. To solve it, a first approach using simulations was carried out. The simulations are essential to understanding the dynamics, since the ordinary field data are from sugarcane crops, which use pest control whenever economic injure is found. In the simulation, a gaussian distribution was attributed to age and number of offsprings, which revealed that for an isolated pest population the growth was indeed exponential, as the differential model supposes, and the interaction between the two populations are now being implemented.

Finally, we hope that our results help sugarcane plants to better use biological control, so less chemicals are used for that purpose."

P2 - Ectomycorrhizal fungal community dynamics in new soil habitats

Kristina Schröter[1], Andrea Polle[1], Rodica Pena[1]

[1]Institute for Forest Botany and Tree Physiology, Göttingen, DE, rpena@gwdg.de

Ectomycorrhizal (EM) fungi, symbiotically associated with plant roots, dominate temperate and boreal forest soils and play an essential role in plant growth, nutrient cycling, and food web dynamics. One of the central goals of ecology is to understand the factors that impact the assembly of ecological communities and how community composition changes through the time. Although EM community successional stages have been well documented by numerous field surveys, the “community assembly rules” are still poorly understood. In this study, we investigated the EM community successional dynamics following colonization of a new soil habitat. In small soil cores of 50 cm^2 area in a beech forest, the roots were severed from the tree and, thus, the EM fungi deteriorated. These quasi-undisturbed soil sites were rapidly colonized by new root in-growth and EM fungal assemblages. The inspection of EM assemblages for two consecutive years allowed us to test whether EM community assembly is driven by tradeoffs in the colonization abilities and species functional traits (i.e., EM exploration types). The experimental set-up simulated the result of the common forestry practices by which trees are removed from the forests while a considerable amount of fine roots remains in the soil creating new sites for EM root development.

The funds were provided by DFG in thepriority program“Biodiversity Exploratories”.

P3 - Effect of alien species on phylogenetic structure of plant species pools

Zdenka Lososová[1]

[1]Masaryk University, Brno, CZ, lososova@sci.muni.cz

One of the key questions of invasion biology is to identify which factors facilitate species invasion. A number of hypotheses postulate that invasion is controlled by the interplay between the phylogeny of the invasive species and phylogenetic structure of invaded communities. Some of them suggest that either phylogenetic relatedness of invaders to native communities is predicted to promote naturalization, which makes alien species closely related to native species more successful invaders, because of appropriate niche-adaptation. Other hypothesis predicts that phylogenetic relatedness hamper naturalization because of niche overlap with native species. We thus ask if differences in phylogenetic structure of native species pools affect the number of invasive species (e.g. level of their invasion).

We used species pools of 88 vegetation types of central Europe, comprising 2306 species. For each species pool, we quantified phylogenetic diversity using the mean phylogenetic distance (MPD) and mean nearest taxon distance (MNTD) to test the relationship between these phylogenetic quantifiers and the level of invasion.

The level of invasion was strongly vegetation type-dependent, and it depends on both the phylogeny structure of the species pools and the phylogeny of the invasive species. The most-invaded species pools were those of anthropogenic habitats and open riverine, wet or mesic meadows. These species pools are phylogenetically more clustered possibly due to disturbance acting as environmental filter. Here, invasive species increased the degree of phylogenetic clustering as they tend to be from the same lineages as native species. Such trends were not detected for phylogenically diverse species pools like those of forests. Our findings do not support the Darwin's naturalization hypothesis per se; they rather suggest that the contrary hypothesis of environmental filtering is the mechanism in play.

P4 - Conspecific and phylogenetic density-dependent survival differs across life stages in a tropical forest

Yan Zhu[1], Liza Comita[2,3,4], Stephen Hubbell[5], Keping Ma[1]

[1]State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, Beijing, CN, zhuyan@ibcas.ac.cn
[2]School of Forestry & Environmental Studies, Yale University, New Haven, US
[3]Department of Evolution, Ecology, and Organismal Biology, The Ohio State University, Columbus, US
[4]Smithsonian Tropical Research Institute, Balboa, Ancón, PA
[5]Department of Ecology and Evolutionary Biology, University of California, Los Angeles, US

1. Ecologists have long recognized that plant performance is affected by the density and composition of neighboring individuals. With the advent of highly resolved

species-level phylogenies, it has become possible to test whether such density-dependent neighborhood interactions are also phylogenetically-dependent. Most studies of density dependence have focused on a single life stage; however, the relative importance of different neighborhood interactions may shift over the lifetime of an individual.

2. We examined effects of conspecific neighbor density, heterospecific neighbor density, and average phylogenetic relatedness of heterospecific neighbors on the survival of seedlings, saplings, juveniles and adult trees of 29 focal tree species using long-term, spatially-explicit forest dynamics data and a highly resolved DNA barcode phylogeny from the tropical forest of Barro Colorado Island (BCI), Panama.

3. Our results show a decline in the strength of conspecific negative density dependence across life stages: strong negative conspecific neighbor effects at early life stages gave way to weak positive conspecific neighbor effects for adult trees. In contrast, the effect of heterospecific neighbor density on survival showed no clear trend with life stage.

4. We found evidence of phylogenetic density dependence in the BCI forest, with a

significant negative impact of neighborhood relatedness on focal tree survival, but only for later life stages. In contrast to studies from other tropical forests, neighborhood relatedness had a significant positive effect on seedling survival.

5. Furthermore, we found that focal species varied much more widely in their sensitivity to conspecific neighbor density than in their reactions to heterospecific neighbor density or phylogenetic relatedness.

6. Synthesis. Overall, our results demonstrate that both conspecific density dependence and phylogenetic density dependence influence tropical tree survival, but that their relative importance varies with life stage and among species. Our study highlights the need to incorporate multiple life stages and multiple species when assessing the factors contributing to individual survival and species coexistence for long-lived organisms.

Key-words: density dependence, determinants of plant community diversity and structure, Janzen-Connell hypothesis, neighborhood analysis, phylogenetic relatedness, seedlings dynamics, species coexistence, tropical forest

P5 - Urbanization shapes bird communites and nest survival, but not their food resources

Kornélia Kurucz[1], Gábor Kemenesi[1], J. Jenő Purger[1], Péter Batáry[2]

[1]University of Pécs, Faculty of Sciences, Institute of Biology,, Pécs, HU, kornelia.kurucz@gmail.com
[2]Georg-August University, Agroecology, Göttingen, DE

With the rapid expansion of urban development, the importance of understanding the relationship between birdlife and urban habitats is strongly needed. To explore the role of urban areas in avian assemblages, we examined differences in species richness and abundance along an urbanization gradient (urban, suburban, rural) in a Hungarian mid-size city (Pécs). Additionally, nest survival probabilities were assessed by using artificial shrub nests and potential food sources (arthropods captured with sticky traps and dummy caterpillars) were compared along the gradient. We observed significantly higher bird species richness in the urban and rural areas compared with suburban areas with far the highest bird densities in the most urbanized areas. Hence the urban areas were dominated by some common urban resistant bird species, whereas the highest Shannon diversity characterized the rural areas. However, daily nest survival rates appeared to be lower in rural than in suburban or urban habitats, where predation rates of nests were negligibly low. Finally, overall arthropod prey abundance and predation rate of caterpillars were not related to urbanization gradient. Hence our results suggest that high level urbanization might increase bird richness and densities, but these communities are dominated by some generalist species such as blackbird, rock dove or by building nester species such as swift. Nesting in urban areas may be safer compared to rural habitats, due to fewer predators and/or the much favourable nesting sites provided by cities. Nevertheless, availability of food sources namely abundance of insects and predation on artificial prey were independent of the level of urbanization, suggest that food availability per se is not key driver in habitat selection within an urbanization gradient. So, future studies should assess the effect of natural and human-provided food availability as well the differences in survival and dispersal between urban and non-urban populations.

END OF SESSION 14

Session 19 - Biogeochemical cycles in a changing environment
Short title: Biogeochemical cycles

CHAIRS: ANSGAR KAHMEN, ALEXANDER KNOHL

O1 - Nitrous oxide and methane emissions from cryptogamic covers

Katharina Lenhart[1,2,3], Bettina Weber[2], Wolfgang Elbert[2], Jörg Steinkamp[4], Tim Clough[5], Paul Crutzen[2], Ulrich Pöschl[2], Frank Keppler[2,3]

[1]Justus-Liebig-University, Gießen, DE, katharina.lenhart@bot2.bio.uni-giessen.de
[2]Max-Planck-Institut für Chemie, Mainz, DE, katharina.lenhart@bot2.bio.uni-giessen.de
[3]Ruprecht-Karls-Universität, Heidelberg, DE, katharina.lenhart@bot2.bio.uni-giessen.de
[4]Senckenberg Gesellschaft für Naturforschung, Frankfurt, DE
[5]Lincoln University, Lincoln, NZ

Cryptogamic covers, which comprise some of the oldest forms of terrestrial life on Earth, have recently been found to fix large amounts of nitrogen and carbon dioxide from the atmosphere (Elbert et al., 2012). Here we show that they are also greenhouse gas sources with large nitrous oxide (N_2O) and small methane (CH_4) emissions. Whilst N_2O emission rates varied with temperature, humidity, and N deposition, an almost constant N_2O:CO_2 emission ratio was observed for numerous lichens and mosses. With the assumption that the robust N_2O:CO_2 emission ratio can be transferred to ecosystem scale, we employed this ratio to obtain a first estimate of the global and regional environmental impact of this newly discovered N_2O source.

If our laboratory measurements are typical for lichens and mosses living on ground and plant surfaces and scaled on a global basis, we estimate a N_2O source strength of 0.32 - 0.59 Tg yr^{-1} for the global N_2O emissions from cryptogamic covers. Thus our emission estimate might account for 4 to 9% of the global N_2O budget from natural terrestrial sources. In a wide range of arid and forested regions, cryptogamic covers appear to be the dominant source of N_2O. Isotopic labeling experiments using ^{15}N in ammonium nitrate indicated that the cryptogamic formation of N_2O is related to NO_3^- reduction, suggesting that the mechanism might be similar to the aerobic and nitrate-based pathways reported for N_2O formation in vascular plants (Smart and Bloom, 2001, Hakata et al., 2003). We suggest that greenhouse gas emissions associated with this source might increase in the course of global change due to higher temperatures and enhanced nitrogen deposition.

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O2 - Quantifying gross fluxes of nitrous oxide in temperate forests

Yuan Wen[1], Marife D. Corre[1], Edzo Veldkamp[1]

[1]Buesgen Institute, Soil Science of Tropical and Subtropical Ecosystems, Georg-August-University of Goettingen, Goettingen, DE, ywen@gwdg.de

Soils are not only a major source but also a potential sink for atmospheric nitrous oxide (N_2O), which is a potent greenhouse gas and the most important substance for stratospheric ozone depletion. Net N_2O flux at the soil surface is a balance between gross N_2O emission and uptake. However, little is known about the magnitude of gross N_2O emission and uptake as these two processes are concurrently taking place, making them difficult to be distinguished by the bulk concentration measurement. Here, we used the $^{15}N_2O$ pool dilution method to disentangle gross N_2O emission from gross N_2O uptake at the soil-atmosphere interface in two adjacent (spruce and beech) forests in Lower Saxony, Germany. Measurements were carried out by in-situ incubation of intact soil cores, taken separately for the organic horizon and 0–5 cm mineral soil, and conducted monthly from May to October 2014. Net N_2O emission rates from the spruce forest were 0.19±0.02 µg N kg^{-1} h^{-1} and 0.03±0.03 µg N kg^{-1} h^{-1} in the organic and mineral soil layers, respectively, which were lower than those from the beech forest with corresponding net fluxes of 0.78±0.23 µg N kg^{-1} h^{-1} and 0.50±0.08 µg N kg^{-1} h^{-1}. Gross N_2O emission rates from the spruce (0.77±0.13 µg N kg^{-1} h^{-1}) and beech forests (1.20±0.21 µg N kg^{-1} h^{-1}) did not significant differ in the organic layer, whereas in the mineral soil these were greater in the beech (0.81±0.12 µg N kg^{-1} h^{-1}) than the spruce forests (0.24±0.04 µg N kg^{-1} h^{-1}). Gross N_2O uptake rates ranged from 0.17±0.03 µg N kg^{-1} h^{-1} to 0.51±0.06 µg N kg^{-1} h^{-1}, and no statistical difference was detected between beech and spruce forests for each soil layer. Gross N_2O uptake accounted for 106±9.5% and 48±7.8% of gross N_2O emission in the spruce and beech forests, respectively. Our results demonstrate that a major part of gross N_2O emission was recaptured by the soils of both studied forests, indicating that such temperate forest soils play an important role as sink of atmospheric N_2O.

O3 - Exceedance of Critical loads for N - Calculations based on tissue N content of lichens and modelled N deposition data in Germany

Stefanie Boltersdorf[1], Martijn Schaap[2]

[1]Universitiy Bielefeld, Bielefeld, DE, Stefanie.Boltersdorf@uni-bielefeld.de
[2]TNO, Utrecht, NL

The German deposition network contributes to the European Monitoring and Evaluation Programme (EMEP), which operates under the Long-Range Transboundary Air Pollution (LRTAP) convention in Europe. The objective of the programme is to model and predict the deposition of acidifying and eutrophying pollutants on a European scale. However, biomonitors may serve as possible alternatives to get a spatially representative picture of the deposition conditions. The present study therefore compares the ability of lichens to reflect the atmospheric deposition of N compounds in terrestrial ecosystems. We tested whether data obtained from these bioindicators correlate with modelled data from N deposition assessment programmes and whether tissue N contents of lichens can additionally be used to refine local estimates of the exceedance of critical loads (CLOs).

Lichen sampling has been adapted to the regional deposition monitoring network in the western part of Germany. Apooled sample (three to five thalli per one sample tree) of each lichen species (N-tolerant *Xanthoria parietina* (L.) Th. Fr. and of nitrophytic *Physcia adscendens* (Fr.) Oliv. and/or *Physcia tenella* (Scop.) DC.) was collected. Using a linear regression between MAPESI (Modelling of Air Pollutants and EcoSystem Impact)-modelled and PINETI (Pollutant Input and EcosysTem Impact)-modelled total N deposition data and tissue N content in different lichen species, the local total N deposition could be deduced and finally exceedances of CLOs could be mapped.

It has been found that more than 80% of all investigated study sites exceed the empirical CLO range for lichens and algae in temperate and boreal forests (5 to 10 kg N $ha^{-1}yr^{-1}$). The most N affected regions could be identified by using geostatistics.

Finally we investigate that the measurement of N accumulation can additionally be used to refine local estimates of the exceedance of CLOs by the definition of critical tissue N content.

O4 - Long-term anthropogenic nitrogen deposition enhances carbon sequestration in boreal forest soils

Nadia Maaroufi[1], Annika Nordin[3], Niles Hasselquist[1], Lisbet Bach[2], Kristin Palmqvist[2], Michael Gundale[1]

[1]Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Umeå, SE, nadia.maaroufi@slu.se
[2]Department of Ecology and Environmental Science, Umeå University, Umeå, SE
[3]Umeå Plant Science Center, Department of Forest Genetics and Plant Physiology, Swedish University of Agricultural Sciences, Umeå, SE

It is proposed that carbon (C) sequestration in response to reactive nitrogen (N_r) deposition in boreal forests accounts for a large portion of the terrestrial sink for anthropogenic CO_2 emissions. While studies have helped clarify the magnitude by which N_r deposition enhances C sequestration by forest vegetation, there remains a paucity of long-term experimental studies evaluating how soil C pools respond. We conducted a long-term experiment, maintained since 1996, consisting of three N addition levels (0, 12.5, and 50 kg N ha^{-1} yr^{-1}) in the boreal zone of northern Sweden in order to understand how atmospheric N_r deposition affects soil C accumulation, soil microbial communities, and soil respiration. We hypothesized that soil C sequestration will increase, and soil microbial biomass and soil respiration will decrease, with disproportionately large changes expected compared to low levels of N addition. Our data showed that the low N addition treatment caused a non-significant increase in the organic horizon C pool of ~15%, and a significant increase of ~30% in response to the high N treatment relative to the control. The relationship between C sequestration and N addition in the organic horizon was linear, with a slope of 10 kg C kg^{-1} N. We also found a concomitant decrease in total microbial and fungal biomasses, and a ~11% reduction in soil respiration in response to the high N treatment. Our data complement previous data from the same study system describing aboveground C sequestration, indicating a total ecosystem sequestration rate of 26 kg C kg^{-1} N. These estimates are far lower than suggested by some previous modelling studies, and thus will help improve and validate current modelling efforts aimed at separating the effect of multiple global change factors on the C balance of the boreal region.

O5 - Global comparison of climatic extreme event impacts on ecosystem carbon fluxes

Janis von Buttlar[1], Miguel D. Mahecha[1], Jakob Zscheischler[3], Anja Ramming[4], Alexander Knohl[5], Dario Papale[6], Markus Reichstein[1], FLUXNET PIs[2]

[1]MPI for Biogeochemistry, Jena, DE, jbuttlar@bgc-jena.mpg.de
[2]misc. institutions, ,
[3]ETH, Zuerich, CH
[4]PIK, Potsdam, DE
[5]Georg-August-Universität, Göttingen, DE
[6]UNITUS, Viterbo, IT

Climatic extreme events, in particular heat waves, droughts or cold spells, directly impact ecosystem functioning and carbon cycle dynamics like photosynthesis or ecosystem (carbon) respiration. Current research on these impacts has mainly focused on individual sites and cases of singular large scale events. Here we present a first global, cross-ecosystem analysis to generalize site level findings and to investigate drivers for differences in impacts.

We detect climatic extreme events in site level meteorology and assess their impacts in carbon flux measurements. We quantify the extremes impact on photosynthesis, respiration and the net carbon balance for single (i.e. heat waves) and combined extreme events (i.e. high temperature together with water scarcity). In particular we investigate how these impacts differ according to event duration and intensity, timing within the growing season or, from the ecosystem perspective, ecosystem type, its resilience or history.

Globally we find that heat extremes alone have a slight positive impact (i.e. cause an increase) on respiration but a much smaller impact on photosynthesis which results in slight reduction of the carbon sink capacity of the effected ecosystems. Co-occurring heat extremes and water scarcity result in strong reductions of photosynthesis and a weaker reduction of respiration and, hence, a decrease of the net carbon sink potential of the ecosystem. The impacts of both types of extremes systematically increase with duration.

However, the most interesting finding is that the magnitude and even the direction of these impacts differs strongly between individual sites. Similar types of extreme events are partly causing opposing (i.e. positive vs. negative) impacts on individual sites. We systematically investigate factors that could explain these differences in ecosystem resilience like timing during the growing season.

O6 - Response of CO2 fluxes to climate anomalies in two forests with different species composition and management

Rijan Tamrakar[1,3], Mathias Herbst[2], Mark Rayment[3], Fernando Moyano[1], Alexander Knohl[1]

[1]Göttingen University, Göttingen, DE
[2]Thünen Institute of Climate-Smart Agriculture, Braunschweig, DE
[3]Bangor University, Bangor, UK, rijan.tamrakar@gmail.com

Climate anomalies impact carbon fluxes of forest ecosystems. Yet, it is unclear, how differences in forest composition and structure due to different management modify such impacts. Here we report on eddy covariance measurements of CO_2 fluxes in an unmanaged old-growth forest with admixtures of ash (*Fraxinus excelsior L.*) and sycamore (*Acer pseudoplatanus L.*) trees at Hainich and a regularly thinned managed even-aged forest of about 130 years old pure beech stand at Leinefelde.

From 2003 to 2012, three major anomalous climate events were observed in both sites. These include warm and dry August in 2003, warm July in 2006 and a late frost in May 2011. In August 2003, the reduction in monthly net ecosystem productivity (NEP) and gross primary production (GPP) was more pronounced in Hainich than Leinefelde probably due to a stronger response of the ash trees to drought than of beech at this particular time of the year. In 2004, annual NEP at both sites was lower coinciding with a strong fruit production of the beech trees. Whether a carry-over effect of the 2003 drought may have contributed to this reduction in NEP remains unclear. During July 2006, the monthly mean air temperature was about 21.5 ^{o}C which is the warmest July in the observed period 2000-2012. Also, water stress of 15 days in Hainich and 12 days in Leinefelde with relative extractable soil water below 0.4 was observed. Monthly NEP in July generally increased with air temperature, but decreased with air temperature in years with high water stress. Usually, NEP in May increased with air temperature (r^2 = 0.602 and p = 0.025

for Hainich and r2= 0.601 and p = 0.025 for Leinefelde). Monthly NEP in May is on average 30 g C m^{-2} $month^{-1}$ higher for Leinefelde than Hainich as ash trees present at Hainich leaf out later than beech and thus reduce the overall net carbon uptake compared to a pure beech stand. In May 2011, two and one late frost days were observed in Hainich and Leinefelde respectively. The difference in NEP between Leinefelde and Hainich was reduced to less than 10 g C m^{-2} $month^{-1}$ indicating the higher impact of late frost on Leinefelde where all the trees already had leaves. We conclude that the impact of anomalous climate events such as frosts and droughts depends on species-specific leaf phenology.

O7 - Century long assessment of herbaceous plants‘ physiological responses to climate change in Switzerland

Cristina Moreno-Gutierrez[1], Rolf Siegwolf[2], Ansgar Kahmen[1]

[1]University of Basel, Basel, CH, cristina.morenogutierrez@unibas.ch
[2]Paul Scherrer Institute (PSI), Villigen, CH

Importantly, plant physiological responses to climate change could influence global carbon and water cycles and could ultimately drive changes in plant communities' distribution and biodiversity. These responses may be species specific and their magnitude was found to decrease with time. This indicates possible long-term processes of acclimation and adaptation in plants and urges the need to assess the long-term responses of plants to climate change.

The isotopic analysis of archived plant material offers the exceptional opportunity to reconstruct the physiological activity of plants over long time periods. Previous studies analysing the physiological activity of plants over long time periods have largely focused on the stable isotope analyses of tree ring chronosequences. Trees represent, however, less than 2% of plant species found in Switzerland. The stable isotope analysis of herbarium samples offers the opportunity to reconstruct the physiological processes of a large range of different plant species from different environments.

The objective of this study is to assess the long-term physiological responses of herbaceous plant species from diverse environments and functional groups to changes in climate occurred during the past centuries in Switzerland. Given their physiological preconditioning, we expect that plant species with different functional strategies and from contrasting environments will show different long-term physiological responses to changes in climate during the last centuries.

In order to do so, leaf herbarium samples from a large number of herbaceous plants species are analysed for their stable oxygen and carbon isotope ratios. Samples are collected from the unique herbaria hold at the University of Basel which cover 600'000 specimens collected mostly in Switzerland since the 18th century for a wide range of species and environments in Switzerland.

O8 - Do carbon reserve concentrations really indicate the carbon balance of a plant?

Günter Hoch[1]

[1]Department of Environmental Sciences, University of Basel, Basel, CH, guenter.hoch@unibas.ch

The question, if plant functions are currently carbon (C) limited or not is central to predict the C balance of plants and ecosystems under future environmental changes. Tissue concentrations of non-structural carbohydrates (NSC) have been increasingly used to infer the C supply status of plants, assuming that they are largely regulated by the net-balance between the photosynthetic C uptake and the sum of all C sink activities (i.e. 'passively' regulated). More recently, this bucket model for C storage has been questioned by new findings that suggested the maintenance or enhancement of C reserve pools against the prevailing demand from other C sink activities in plants (i.e. 'actively' regulated reserve pools). In plants exposed to C limitation, the formation of C reserves might thus be in competition with other C sinks, like growth, which in turn would limit the predictive value of NSC concentrations as a proxy for a plant's C balance.

This presentation will summarize the results of recent experiments with tree saplings that used different approaches to alter the plants' C balance (low or high CO_2, shading, defoliation) in order to investigate the mechanisms and controls of C reserve formation in trees. In general, C reserves reacted like 'passive' pools during the first half of the growing seasons, with strong declines of NSC concentrations in C limited saplings, and increased tissue NSC concentrations under C oversupply. In contrast, during the second half of the growing season, C reserve pools increased significantly even under severe C limitation, resulting in comparatively small, but still persistent, differences of NSC concentrations among different C supply treatments. These experiments thus indicated a preferential allocation of photoassimilates to storage towards the end of the growing season, although they could not unambiguously answer, if this increase occurred indeed at the expense of growth. In conclusion, the overall lower NSC concentrations in C-limited saplings support the usability of C reserves as indicators for C limitation, but the increased allocation of C to storage before the dormant season even under severe C shortage might limit the explanatory power of NSC concentrations to quantify the precise magnitude of C source-sink imbalances.

P1 - Impact of tree diversity, forest age and environmental factors on leaf litter decomposition in subtropical forests in China

Stefan Trogisch[1,2], Jin-Sheng He[3], Andrew Hector[4], Michael Scherer-Lorenzen[5]

[1]Institute of Biology, Geobotany and Botanical Garden, Martin-Luther-University Halle-Wittenberg, Halle, DE, stefan.trogisch@botanik.uni-halle.de
[2]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE,

stefan.trogisch@botanik.uni-halle.de
[3]Department of Ecology, College of Urban and Environmental Sciences and Key Laboratory for Earth Surface Processes of the Ministry of Education, Peking University, Beijing, CN
[4]Department of Plant Sciences, University of Oxford, Oxford, UK
[5]Faculty of Biology, Geobotany, University of Freiburg, Freiburg, DE

Litter decomposition is an integral component of the global cycles of nitrogen, phosphorous and carbon and connects above- and belowground biotic processes. Tree diversity is considered to influence decomposition processes either by changing environmental conditions or by the occurrence of non-additive litter mixture effects. The aim of this study was to examine the influence of tree species richness, forest age and environmental factors on single-species decomposition, and to test the hypothesis that high litter species diversity induces positive non-additive mixture effects on decomposition processes.

Three complementary decomposition trials were performed in a diverse subtropical forest ecosystem in China. First, decomposition rate of leaf litter derived by the abundant tree species *Schima superba* was related to environmental factors across 27 subtropical forest stands differing in age and tree species richness. Second, the decomposition constant of 26 tree species was determined under homogenous physical and biological site conditions. And third, the influence of litter species richness on decomposition and N loss of 27 plot-specific litter mixtures comprising 7 to 17 species was assessed.

Decomposition rate of *Schima superba* leaf litter was mainly affected by stand characteristics (tree basal area) and microclimate (humidity) but not tree diversity. Decomposition constants of single-species litters ranged from 0.23 to 0.95 yr^{-1} with interspecific variation negatively related to initial litter C:N ratio. Two thirds of plot-specific litter mixtures showed a positive non-additive mixture effect whose strength was marginally positively influenced by litter species richness.

According to our results tree diversity at stand level does not directly influence decomposition of a common litter substrate. However, evidence from this study suggests that tree species diversity in the litter layer can indirectly promote decomposition and nutrient cycling via positive non-additive mixture effects.

P2 - Realistic Carbon Pools and Diffusivity Limitations to Simulate and Understand Carbon Cylcing in Soils

Fernando Moyano[1]

[1]Bioklimatologie, Universitaet Goettingen, Goettingen, DE, fmoyano@uni-goettingen.de

Most soil carbon models developed over the last cuople of decades have been unable to accurately predict the correct magnitudes and temporal variations in observed carbon fluxes and stocks. New models are now being developed that attempt to address the shortcomings of these previous more simple models. While

many variations of new ideas are finding their way into current models, the addition of only a few new processes known or thought to play important roles in soils seems very promising for resolving a large number of previous model-data discrepancies. In addition, these processes provide new insights and hypotheses of what soil carbon pools are and how they behave.

This study presents a new generation model of soil carbon dynamics that combines a number of processes in a relatively simple but flexible framework. Several pools are different from traditional carbon pools (e.g. the RothC or Century models) in their basic characteristics. These include carbon that is sorbed or in disconnected zones, as well as microbial biomass and enzyme carbon. Similar to other new-generation models, key processes that limit carbon decomposition are included, namely enzymatic activity and diffusion. While more complex in terms of the number of parameters and diversity of carbon pool, this model is significantly more realistic than traditional models and allows exploring several mechanisms that can explain observed variations in fluxes and pools.

This study tests the potential of this model to simulate such dynamics. Soil respiration rewetting pulses, priming effects and other dynamics are simulated by adding mechanims that allow for feedbacks and non-linear dynamics. This study starts from a theoretical basis and proceeds to test against available data in order to obtain a predictive model. Finding the most effective model structure and parameterization by means of a data-driven analysis remains essential for all new models in soil carbon science.

P3 - Using a complex field study of energy crops to separate climate, fertilization and crop effects on N2O emissions

Ulrike Hagemann[1], Sebastian Fiedler[2], Gawan Heintze[3], Marcus Rohwer[4],
Madlen Pohl[1], Jürgen Augustin[1]

[1]Leibniz Centre for Agricultural Landscape Research (ZALF) e.V., Müncheberg, DE,
ulrike.hagemann@zalf.de
[2]University of Rostock, Landscape Ecology and Site Evaluation, Rostock, DE
[3]Hochschule Weihenstephan-Triesdorf, Vegetation Ecology, Freising, DE
[4]Christian-Albrechts-University Kiel, Institute for Plant Nutritrion and Soil Science, Kiel, DE

Despite an increasing cultivation of energy crops for the production of biogas aiming to reduce the overall climate impact of the agricultural sector, it is still largely unknown how the application of ammonia-rich organic digestates effects field N_2O emissions. Apart from abiotic (e.g., temperature, moisture) and biotic factors (e.g., microbes), N_2O emissions from agricultural soils largely depend on so-called distal factors like fertilization regime, crop, and management practices. However, the individual effects of these factors on N_2O emissions are difficult to quantify as the high, mainly climate-related spatio-temporal variability of N_2O fluxes and the often non-linear interactions between many factors complicate the quantification of fertilization and crop effects.

We will present results from a 4-year field study at 5 sites in Germany investigating the interacting effects of i) 3 N-fertilizer treatments (100% organic digestates (ORG), 100% mineral (MIN); 50% ORG + 50% MIN) and ii) 7 energy crops on N_2O emissions. Study sites represent the major precipitation-frost classes relevant for N_2O production in Germany (Jungkunst et al. 2006). Using identical sampling methods at all sites, N_2O was measured periodically from 05/2011–09/2014 at 3 replicate plots per treatment using opaque non-flow-through non-steady-state chambers, 20-min interval sampling and gas chromatography. N_2O fluxes were calculated via linear regression using standardized protocols for data processing and interpolation between measurements. Our results show that multi-year field experiments with replicate crop rotations at multiple sites and identical design generate large N_2O datasets which can be used to separate underlying crop and fertilization effects from climate-induced variability and to improve models, which in turn will contribute to more reliable predictions of N_2O emissions following changes in agricultural management.

P4 - Effects of nitrogen fertilization on rice productivity in S. Korea

Steve Lindner[1]

[1]Plant Ecology, BayCEER, University of Bayreuth, Bayreuth, DE, stevelindner@yahoo.de

Rice (*Oryza sativa* L.) is an important food crop, covering about 150 million hectares of land. Rice yields depend on the levels of nitrogen (N) fertilization. On average, the yields are still below the production potential. This calls for the need to determine appropriate dosages of N-fertilizer application that is both economical and appropriate to enhance productivity.

Field measurements were conducted to quantify the effects of different fertilization intensities on the productivity of a new hybrid rice variety, Unkwang. The treatments comprised 4 levels of nitrogen-application at a rate of 0, 50, 115 and 180 kg-N ha^{-1}, respectively. The 4 experimental fields represented each a 73 m x 7 m experimental plot. The recommended nitrogen fertilization for this rice variety of 115 kg-N ha^{-1} was applied manually.

Measurements included above- and belowground biomass, leaf area index (LAI), plant nitrogen content, net ecosystem CO_2 exchange (NEE), ecosystem respiration (R_{eco}) and crop yield. Gross primary production (GPP) was calculated from NEE and R_{eco}, while quantum yields (α) and potential maximum assimilation were determined using a hyperbolic light response model. Weather data above the canopy were continuously measured with a weather station.

Peak leaf-N contents were 2.49, 2.62, 2.94, 2.88%, while peak LAI's were 4.91, 4.15, 6.43, 6.18 cm/cm^{-2} in the 0, 50, 115 and 180 kg-N ha^{-1} plots, respectively. The respective peak aboveground biomasses were 15.98, 14.23, 22.37, 16.65 kg/m^{-2}, while the final yields were 7.17±2.21, 10.11±2.10, 10.69±2.43, 12.43±0.46 t/ha^{-1}. The maximum GPP recorded were 25.05±2.66, 23.14±2.28, 30.03±3.53, 30.79±0.37 µmol m^{-2} s^{-1} on the 0, 50, 115 and 180 kg-N ha^{-1} plots, respectively. The α and potential maximums of GPP were positively correlated for all fertilization rates (R^2 = 0.89). Differences among the crops were attributed to N-fertilization levels. Sustainable agricultural practices and the introduction of high yielding rice varieties may increase nitrogen use efficiency (NUE), reduce quantities of N-fertilization, which is associated with pollution of water resources in the South-Korean agricultural landscape.

P5 - The biosphere-atmosphere CO2 fluxes of a montane rainforest

Florian Heimsch[1], Heinrich Kreilein[1], Abdul Rauf[2], Alexander Knohl[1]

[1]University Göttingen, Bioclimatology department, Göttingen, DE
[2]University Tadulako, Palu, ID

Tropical rainforests in mountain regions are some of the remaining forests of Indonesia with little direct human interventions. Due to their remoteness, they still are close to their original species compositions and maintain important ecosystem functions, such as related to the carbon and water cycles. Yet, little quantitative data exist on carbon storage and biosphere-atmosphere exchange of carbon dioxide (CO_2) or water vapour of such forests.

Here we report on eddy covariance measurements in a montane rainforest in Central Sulawesi in Indonesia. This region has been selected as one of the few pilot sites in Indonesia for the United Nations REDD+ program requiring detailed information about the forest's carbon cycle. The eddy covariance tower is located in the Lore Lindu National Park at a mountain plateau at 1440 m a.s.l. and is surrounded by primary rainforest. Mean annual temperature is 19.5°C with rainfall exceeding 2000 mm per year resulting in high water availability at any time over the year. Besides the eddy covariance measurements we are also recording CO_2 concentration in a vertical profile to quantify the CO_2 storage flux in order to estimate the CO_2 exchange under condition of low wind speed and low turbulent exchange. Additionally, we record a wide range of micrometeorological variables such as air temperature, air humidity, wind speed at different heights, as well as in- and outgoing long and short wave radiation.

Our results indicate that this primary forest is not at equilibrium but acts as a strong carbon sink. We present results on quality control of the eddy covariance CO_2 flux measurements and estimations of the CO_2 storage flux derived from the vertical CO_2 concentration profile.

P6 - Insect mass outbreaks affect the C, N and P balance in forest ecosystems

Maren Grüning[1], Carsten Thies[4], Bernd Zeller[3], Annett Reinhardt[1], Petra Lasch[5], Judy Simon[2], Anne le Mellec-Arnold[1]

[1]Georg-August Universität Göttingen; Soil Science of Temperate Ecosystems, Göttingen, DE, mgrueni1@gwdg.de
[2]Universität Konstanz; Plant Physiology and Biochemistry, konstanz, DE
[3]Institut nationale de la recherech agronomique, Nancy, FR
[4]N-Lab, Winsen, DE
[5]Potsdam Institut für Klimafolgenforschung, Potsdam, DE

Insect mass outbreaks affect the C, N and P balance in forest ecosystems in various ways. The above- and below-ground fluxes and storages of the subsystems in forests are influenced both qualitatively and quantitatively by the altered inputs via litter, through fall, consequently leading to changing organic layer properties and matter output.

From the ecological perspective it is important to investigate how and to what extent insect pests can influence the dynamics of the C, N and P flows in the forest, thereby regulating the forest functions. Therefore understanding these effects is important for evaluating the ecological processes which will subsequently facilitate the development of adaptable and predictive management strategies - this based on the fact that specifically under changing climatic conditions, the magnitude, frequency, intensity and duration of insect mass outbreaks are predicted to increase.

Our ongoing research projects on effects of insect mass outbreaks on the C, N and P balance in forest ecosystems are investigating on this research question. In the atmosphere-tree-soil-continuum the projects make a comparative examination in surface and sub-surface components of the C, N and P cycles in temperate forests between infested sites and non-infested control sites. The studies are aimed at an trans- and interdisciplinary approach by combining the fields of microbiology, tree physiology, entomology, bioclimatology, soil science and the tree-soil-communication pathways. Some of the first results (le Mellec-Arnold et al. submitted) will be presented within a poster presentation.

P7 - Effects of global change on the P nutrition of European beech and Palestine oak

Julia Köhler[1], Inga Dirks[2], Hila Gil[2], Christoph Leuschner[1], Shimon Rachmilevitch[2], Ina Christin Meier[1]

[1]Plant Ecology, Albrecht-von-Haller-Institute of Plant Sciences, University of Göttingen, Untere Karspüle 2, 37073 Göttingen, DE, julia.koehler@biologie.uni-goettingen.de
[2]French Associates Institute for Agriculture and Biotechnology of Drylands, The Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, 84990 Midreshet Ben-Gurion, IL

Productivity of temperate and Mediterranean forests may increasingly be limited by shortage of phosphorus (P). First indicators are declining P concentrations, increasing N:P ratios in leaves and fine roots as well as stem growth reductions probably due to P limitation. In the context of global change predicted increases in temperatures and summer droughts in combination with high N deposition are likely to further change the P nutrition of forest trees in the next decades. Inorder to improve predictions about the P nutrition of important forest tree species under global change, multi-factorial experiments (3 soil moisture x 1 or 2 temperature x 2 N supply x 3 P supply levels) are conducted with European beech (*Fagus sylvatica*) and Palestine oak (*Quercus calliprinos*) saplings in Germany and Israel to examine the effects of increasing temperature, decreasing soil moisture, increasing N deposition, and decreasing P availability as well as their interactions on growth, C allocation, P uptake and use efficiencies, and fine root rhizodeposition. P uptake capacity is measured by a ^{33}P-feeding experiment and fine root rhizodeposition with a novel *in situ*-technique for exudate collection. The validity of the obtained results is tested under field conditions on stands of mature beeches and oaks along natural precipitation gradient in northern Germany and Israel. For this purpose stand productivity, leaf and root P concentrations, N:P ratios, rhizodeposition, and the efficiencies of P uptake, use and re-translocation at variable P availabilities along the gradients are measured. Our overarching hypothesis is that the efficiencies of P uptake and P use increase with decreasing P availability in dry and N-rich forest soils. First results indicate increasing root exudation rates with both decreasing precipitation and decreasing P availability. At the same time, microbial activity for P decomposition is increasing with decreasing rainfall.

END OF SESSION 19

Session 22 - Ecological Genetics and Epigenetics in the Omics Era

CHAIRS: PROF. DR. KONSTANTIN V. KRUTOVSKY, PROF. DR. NIKO BALKENHOL, PROF. DR. ELVIRA HÖRANDL

O1 - Increased mutation rate in sexual populations during range expansions

Marleen M.P. Cobben[2], Alexander Kubisch[1,3]

[1]University of Hohenheim, Stuttgart, DE, akubisch@posteo.de
[2]Netherlands Institute of Ecology, Wageningen, NL
[3]Université Montpellier II, Montpellier, FR, akubisch@posteo.de

Increasing dispersal under range expansion increases invasion speed, but only if a species is able to adapt sufficiently fast to novel local conditions. However, the iteration of founder effects during range expansion causes a low level of local genetic diversity at the expanding range margin. Evolvability, in this case the mutation rate of local adaptation, can be an adaptive trait itself. Using an individual-based model we showed co-evolution of dispersal rates and mutation rates, allowing a faster range expansion and a larger species‘ range. This also occurred in sexual populations, due to the particular properties of spatial sorting, and resulted in a long-lasting maintenance of high mutation rates in both sexual and asexual species. By this we extend the existing theory on the evolution of mutation rates, which was thought to be limited to asexual populations, with possibly far-reaching ecological consequences concerning the adaptability of species to novel environmental conditions.

O2 - Genetic analysis of European beech populations across a precipitation gradient: understanding the adaptive potential to climate change

Laura Cuervo[1], Matthias Arend[2], Markus Müller[1], Reiner Finkeldey[1], Konstantin Krutovsky[1]

[1]Department of Forest Genetics and Forest Tree Breeding, Georg-August University of Göttingen, Göttingen, DE, lcuervo@gwdg.de
[2]Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf, CH

European beech (*Fagus sylvatica*) is one of the most important species in Europe. Climate change scenarios for Europe predict drier conditions with less precipitation and higher annual mean temperatures, which may cause also earlier flushing dates in spring and later bud set in autumn, therefore, increase the risk of frost damage. Drastic droughts could also become more frequent and prolonged during summer, and thus, severely affect beech survival. Consequently, the genetic adaptation potential of this species to climate change is of great interest. The main objective of this study is to assess the connection between genetic variability and climate adaptation related traits. For this purpose, both saplings and adults from beech populations located along precipitation gradients were studied using both genetic markers

and important adaptive traits. The saplings were subjected to experimentally controlled soil water shortage, and their morphological and physiological responses to water deprivation were evaluated. In addition, genetic diversity in microsatellite markers and SNPs in drought related candidate genes have been assessed. Morphological and physiological data suggest that saplings belonging to populations with lower precipitation were less affected by water shortage. Analyses of ten random genomic microsatellite loci and three EST-linked microsatellite loci demonstrated that the investigated populations have high genetic diversity and low but significant population differentiation. A lower genetic differentiation was found at the EST-linked microsatellites, which may indicate that the populations are under balancing selection. To gain insight into the genetic variability underlying the genetic adaptive potential of this species to climate change, 80 SNPs in 24 candidate genes associated with drought related traits are genotyped (in progress). This study will contribute to a better understand of the genetic adaptive potential of *F. sylvatica* to climate change.

O3 - The use of molecular markers allows the identification of natural populations and their refuge areas during adverse climatic events.

Ramon Seage[1]

[1]University of Ulm Institut of Evolutionary Ecology and Conservation Genomics, Ulm, DE, ramonseage@hotmail.com

The current climate change is one of the main responsible of the diversity loss the Earth experiments nowadays. The rise of the temperatures implies a change in the environment that many species can not handle, so they will be doomed to the extinction or to the emigration. These processes are not new in the recent history of the Earth. During the Quaternary, massive climate changes restricted the distribution of most of the European species to small spots with suitable conditions. From these localities, called Glacial Refugia, the remaining populations could re-colonize the continent, once the environmental conditions turned warmer. The existence of such areas and its importance is a lesson we can learn from the past, since under current climate changing conditions they could become, again, hotspots for biodiversity conservation.

Using the lesser horseshoe bat (*Rhinolophus hipposideros*) as study species and the HV-II from the mtDNA as molecular marker, we wanted to contribute to the conservation of this bat in the Iberian peninsula by identifying both the existing natural populations (management units) as well as their precedence areas (glacial refugia). The tools that molecular ecology provides, allowed us to reveal a very complex population structure and the existence of, at least, three main glacial refugia, two in the Mediterranean region and one more in the NW of Iberia. This latter is especially relevant since during the last maximum glacial (20 000 years before present) the area was mainly under Boreal climate conditions and the bats have had to survive occupying coastal cryptic refugia. These results should contribute to future management policies for the species and to highlight the importance of low-altitude deciduous forests as hosts during climatic-adverse environmental conditions.

O4 - Population genetics and reproductive strategies of the invasive herb Clidemia hirta in tropical rainforest transformation systems

Nicole Opfermann[1], Elvira Hoerandl[1]

[1]University of Goettingen, Department of Systematics, Biodiversity and Evolution of Plants (with Herbarium), Goettingen, DE, nopferm@gwdg.de

Weedy plants, especially invasive species have a strong impact on tropical ecosystems.Recolonization of disturbed areas by invasive, non-native species is accompanied by covering vegetation, suppressing recruitments of native trees, altering spectra of pollinators, frugivores and herbivores. Among other factors, breeding systems play an important role for invasiveness of species of flowering plants.

Clidemia hirta (Melastomataceae) is native to the Neotropics and one of the most aggressive weeds in SE Asia. The species is light and shade tolerant, known to reproduce via apomixis (asexual seed formation) and the small seeds are dispersed by birds. We are testing the hypothesis that asexual reproduction via seeds (apomixis) is one of the key factors for introduced weeds to reach rapidly dominance in the understory vegetation of plantations, with a high potential to invade natural rainforest systems. We used different methods to quantify apomictic vs. sexual seed formation, by using pollen-exclusion experiments, germination rates and population genetic studies and molecular progeny arrays with nine microsatellite loci. Sampling was conducted in two landscapes in Jambi province, central Sumatra, within each four plots (50mx50m) in palm oil, rubber plantations and jungle rubber. Within the investigated area the species is the most common weed. It is abundant in almost all selected sites of the transformation systems and occurs even in some of the natural forest plots. Preliminary results show that the species reproduces clonally via asexually formed seeds and that population genetic diversity is strongly reduced. Seed set is pollinator-independent and enhanced by formation of multiple embryos within one seed. This study will help us to understand the importance of breeding systems of invasive plants and their invasive potential. Results might help us to control weedy species with apomixis, which becomes a major issue for conservation strategies in tropical ecosystems.

O5 - Genetic Structure of Syzygium guineense Wall. (Myrtaceae) in Forests and Suffrutex-Grasslands of African Miombo Region

Paulina Meller[1], Barbara Rudolph[1], Manfred Finckh[1]

[1]Universität Hamburg, Biozentrum Klein Flottbek, Biodiversity, Ecology & Evolution, 22609 Hamburg, DE, paulina.meller@gmx.de

An undulating mosaic of forests and grasslands characterizes the African Miombo region, which is home to many closely related plant species of similar morphology, except for one aspect: while growing as tree form in forests, their sister taxon grows as dwarf shrub with huge underground biomass (termed suffrutex) in the open grasslands forming an underground forest.

To investigate this phenomenon we chose *Syzygium guineense* Wall. (Myrtaceae) as model plant. This species grows in both woodlands and suffrutex grasslands of the Miombo region. A total of 33 populations were sampled in Angola, Namibia, Zambia and Botswana in order to analyze the relationship of these two and several intermediate morphotypes. Aim of our study is to characterize the genetic structure of this species complex in different habitats. These analyses will show whether the different phenotypes are genetically fixed or are local responses to ecological drivers such as soil humidity, frost and fire regimes or herbivory.

The genetic relationship and putative divergence between the populations is being estimated by sequencing analyses of the internal transcribed spacers of the nuclear rRNA genes (ITS) and the chloroplast *trn*K region. Investigation of the genetic structure between and within populations using microsatellite markers is in progress.

First results suggest that the morphotypes of *S. guineense* can be assigned to at least five distinct genotypes that partly correspond to those subspecies described in literature. One group of intermediate forms is matched to a genotype exhibiting high phenotypic variability, depending on the environment they are exposed to.

Thus, *S. guineense* is an exciting example of how both the genetic and ecological influences affect growth traits and produce extreme morphotypes as a result of adaptation to a remarkable landscape.

O6 - Seeing the forest for the trees - Identifying predictive SNPs for phenotypic variation using random forest

David Behringer[1], Sascha Liepelt[1], Lars Opgenoorth[2], Birgit Ziegenhagen[1], Katrin Heer[1,2]

[1]Philipps-University Marburg, Conservation Biology, Karl-von-Frisch-Strasse 8, 35043, Marburg, DE, david.behringer@uni-marburg.de
[2]Philipps-University Marburg, Department of Ecology, Karl-von-Frisch-Strasse 8, 35043, Marburg, DE

A crucial step towards understanding the response of forest trees to climate change is unraveling the genetic background of local adaptation. While SNP data is now available for many important tree species, it remains challenging to determine the causal variants underlying phenotypic changes. Often, adaptive phenotypic changes are caused by many genes with small effects and their interactions, which presents a challenge to basic analytical methods in association mapping. The “random forest” algorithm, in combination with a repeated stepwise exclusion of the least important SNPs (“backward purging”), offers an approach for the detection of adaptive polymorphisms that accounts for the effects of multiple SNPs and their interactions. We applied this procedure to a data set from a population of silver fir (*Abies alba)* sampled in the Bavarian Forest National Park. At two sites located at 730 and 1100 m a.s.l. we sampled 100 adult trees and 150 saplings, respectively. In total, 480 trees were genotyped with 232 SNPs from previously identified candidate genes. For each tree, we monitored bud burst in spring 2014 and 2015. Additionally we derived indices for individual responses to climate from tree ring data. “Random forest” and “backward purging” was implemented repeatedly on the same data sets to determine which SNPs explained most of the variance in the phenotypic data. Finally we compared these SNPs with those derived from widely used methods, such as MLM implemented in Tassel. First results will be presented during the conference.

P1 - Utility of environmental DNA for monitoring rare and indicator macroinvertebrate species

Elvira Mächler[1], Kristy Deiner[1], Florian Altermatt[1,2]

[1]Eawag Aquatic Ecology, Dübendorf, CH, florian.altermatt@eawag.ch
[2]University of Zurich, Zurich, CH, florian.altermatt@eawag.ch

Monitoring done with conventional methods may have limitations, such as being laborious in terms of cost and time, and often require invasive sampling of specimens. Environmental DNA (eDNA) has been identified as a molecular tool that could overcome these limitations, particularly in aquatic systems. Detection of rare and invasive amphibians and fish in lake and river systems has been effective, but few studies have targeted macroinvertebrates in aquatic systems. We expanded eDNA techniques to a broad taxonomic array of macroinvertebrate species in river and lake systems. We were able to detect 5 of 6 species (*Ancylus fluviatilis, Asellus aquaticus, Baetis buceratus, Crangonyx pseudogracilis*, and *Gammarus pulex*) with an eDNA method in parallel to the conventional kicknet-sampling method commonly applied in aquatic habitats. Our eDNA method showed medium to very high consistency with the data from kicknet-sampling and was able to detect both indicator and nonnative macroinvertebrates. We demonstrate that an eDNA surveillance method based on standard PCR can deliver biomonitoring data across a wide taxonomic range of macroinvertebrate species (Gastropoda, Isopoda, Ephemeroptera, and Amphipoda) in riverine habitats and may offer the possibility to deliver data on a more refined time scale than conventional methods when focusing on single or few target species.

P2 - Towards adaptational genomics in Southern beech (Nothofagus spec.) in Argentina

Maximiliano Estravis Barcalá[1,2], Carolina Soliani[1], Katrin Heer[2], Birgit Ziegenhagen[2], Paula Marchelli[1,2], Maria Verónica Arana[1]

[1]INTA EEA Bariloche, Bariloche, AR
[2]University of Marburg, Marburg, DE, estravis.maximiliano@inta.gob.ar

In the Southern Hemisphere, temperate Patagonian forests are distributed along natural environmental gradients that might be imposing different selection pressures on the native flora. *Nothofagus pumilio* (Lenga), endemic to these forests, is the most important timber species in Patagonia and the second in Argentina due to its huge distribution range and the quality of its wood. Particularly, the species is distributed across a wide latitudinal range (36° to 55° S), constituting also the tree line at high altitudes. Thus, growing in zones of contrasting thermic and photoperiodic characteristics it renders an interesting model for predicting the fitness of trees along with global change scenarios. Moreover, meanwhile in the northern regions (36 - 40° S) *N. pumilio* is found above 1000 m a.s.l, it inhabits both mountain and sea level zones at the extreme south (53 - 55°S), which coincides with the colder environments of these sub-Antarctic forests. This suggests a strong susceptibility of the species to growth in warm environments.

The aim of this work was to characterize the genetic variation at candidate genes in populations of *Nothofagus pumilio* along its natural distribution area. In order to unravel possible climate-driven adaptation we studied patterns of variation in nucleotide sequences of genes potentially associated to temperature and photoperiod perception. In addition we will present the first results of the transcriptome sequencing (RNA-seq) performed to determine changes in gene expression between two different temperatures (20° and 34° C).

END OF SESSION 22

Session 23 - Climate change – from theory to the Field

CHAIRS: RALL, BJÖRN C., BROSE, ULRICH

O1 - Effects of warming on control of primary producers by grazers in rivers

Jose Ricardo Ruiz Albizuri[2], Markus Weitere[3], Karin Johst[2], Karin Frank[2]

[2]Department Ecological Modelling, Helmholtz-Centre for Environmental Research - UFZ, Leipzig, DE, ricardo.ruiz@ufz.de
[3]Department River Ecology, Helmholtz-Centre for Environmental Research - UFZ, Magdeburg, DE

Benthic filter feeders (BFF) are important herbivores that can strongly reduce phytoplankton and thus eutrophication in rivers. Such mechanism (i.e., top-down control of eutrophication) is probably sensitive toward environmental-change related stressors. With respect to warming, experiments suggest that it could affect the relationship between grazing rate and plankton growth by promoting significant eutrophication increases at high temperatures. However, systematic model simulations of warming effects on grazer-controlled phytoplankton are as yet lacking. Here, we developed a model on phytoplankton development in rivers that included temperature dependences for phytoplankton growth and benthic grazing. We tested the effect of the different temperature dependences of both phytoplankton growth and benthic grazing. The results show eutrophication gradients with highest phytoplankton densities at optimum temperatures for phytoplankton growth in the absence of grazers. The presence of BFF changed those patterns fundamentally: at optimal temperatures for grazing, grazers can strongly reduce eutrophication. However, if optimal temperatures for grazing were exceeded, small temperature increases can result in reduced grazing control and rapid eutrophication increases. These results suggest that warming effects on eutrophication control by herbivores are likely to differ between ecosystems with different control modes („bottom-up“ vs. „top-down“) and depending on the abundance of both phytoplankton and grazers, as well as on the temperature dependences of both grazing rate and phytoplankton growth.

O2 - Complexity improves the predictability of ecological networks

Alison Iles[1,2], Mark Novak[2]

[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE, alison.iles@idiv.de
[2]Oregon State University, Corvallis, US, alison.iles@idiv.de

All ecosystems are subjected to chronic disturbances, including harvest, pollution and climate change. The capacity to predict how species respond to such press perturbations is limited by our imprecise knowledge of pairwise species interaction strengths, as well as the complexity of direct and indirect pathways along which perturbations propagate between species. Network complexity has thereby been

seen to limit the predictability of ecological systems. Here we challenge this notion by demonstrating how the influence of indirect effects declines with network complexity when interaction strengths are governed by universal metabolic scaling constraints. These constraints affect a positive relationship between network connectance and the dominance of weak interactions whose presence serves to limit disturbance propagation. This relationship preserves predictability even when pairwise interaction strengths are estimated with substantial uncertainty. Thus, although strongly interacting species drive the dynamic response of ecological networks to disturbances, it is the array of weak interactions that determines the consistency and predictability of these responses.

O3 - The impact of disturbance on biodiversity and ecosystem functioning in multi-trophic communities

Christian Guill[3], Ulrike Feudel[4], Daniel Bearup[4], Bernd Blasius[4], Kerstin Wiegand[1], Björn C. Rall[2], David Ott[1]

[1]University of Göttingen, Göttigen, DE, dott@gwdg.de
[2]German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig, DE
[3]Theoretical Ecology, Institute for Biodiversity and Ecosystem Dynamics, Amsterdam, NL
[4]University of Oldenburg, Oldenburg, DE

The question how the functioning of complex multi-tropic communities reacts to different disturbance scenarios and changing biodiversity levels is crucial to understand biodiversity on ecosystem functioning (B-EF) in nature. In previous research investigating B-EF, neither experimental nor theoretical approaches paid much attention to dynamically disturbed systems that may lead to changes in B-EF relationships, or did this under limited perspectives. Here we investigate how biodiversity and disturbances interactively change ecosystem functions simulating a multi-trophic community with a dynamic bioenergetic model exposed to different disturbance scenarios. Disturbance scenarios differed in their frequency and magnitude. The disturbance decreased randomly biomass of all species in the community and caused extinction of some species. At the same time, the disturbance established new species into the community. We measured the dependent changes in functioning (e.g. ecosystem respiration and gross primary productivity) and analysed the results statistically. Our study represents a consequent development extending previous food-web models with complex communities to dynamics affected by stochastically changing conditions. We found that an increasing frequency of disturbances decrease both, GPP and ecosystem respiration, whereas ecosystem respiration decreases more as GPP, indicating a higher rate of carbon binding with increasing disturbances. Increasing strength of disturbances increases both, ecosystem respiration and GPP. Here, respiration increases more than GPP indicating an increase in CO2 release with increasing strength of disturbances. We believe our model approach to be a promising step to a deeper understanding and forecasting how communities and consequently B-EF relationships react to disturbance effects.

O4 - Do phenology shifts cause day length constraints in aphids?

Jens Joschinski[1], Thomas Hovestadt[2,3], Jochen Krauss[1]

[1]Department of Animal Ecology and Tropical Biology, University of Würzburg, Würzburg, DE, Jens.Joschinski@uni-wuerzburg.de
[2]Department of Animal Ecology and Tropical Biology, Field Station Fabrikschleichach, Rauhenebrach, DE
[3]Department of Biology (TEREC), Ghent University, Ghent, BE

Climate change can alter the phenology of organisms. It may thus lead seasonal organisms to face different day lengths than in the past, and the fitness consequences of these changes are as yet unclear.

We used the pea aphid *Acyrthosiphon pisum* as model organism as it has obligately asexual clones, which can be used to study day length effects without eliciting a seasonal response. We recorded life-history traits under short and long days both with two realistic temperature cycles with means differing by 2°C. In addition we measured the population growth of aphids on their host plant *Pisum sativum*.

We show that short days reduce fecundity and the length of the reproductive period of aphids. Nevertheless this does not translate to differences at the population level, because the observed fitness costs only become apparent late in the individual's life. As expected, warm temperature shortens the development time, leading to faster generation times. We found no interaction of temperature and day length.

We conclude that day length changes cause only relatively mild costs, which may not decelerate the increase in pest status due to climate change.

O5 - Effect of temporal mismatches in bee-plant interactions on the fitness of wild bees

Mariela Wolf[1], Andrea Holzschuh[1]

[1]Biocenter, Department of Animal Ecology and Tropical Biology, Würzburg, DE, mariela.wolf@uni-wuerzburg.de

Global warming strongly threatens the synchronization of mutualistic wild bee-plant interactions when temperature affects the timing of interaction partners differently. However, empirical evidence for fitness consequences due to temporal mismatches is completely lacking for pollinators. The negative impact of desynchronization is expected to be highest for species arising early in the season, when the danger of emergence before potential interaction partners is high, and for specialist species with a very small number of potential interaction partners. Therefore we tested the effect of temporal mismatches on the fitness of three spring emerging wild bee species, including one specialist wild bee species. In 36 flight cages, we either simulated a perfect synchronization or a temporal mismatch of three or six days of bee activity and plant flowering (with wild bees emerging earlier than flower occurrence).

A temporal mismatch of six days caused severe fitness losses in all bee species. Just few individuals survived this time period without plants, females showed a strongly reduced activity and they produced less brood cells. For the specialist *Osmia bicornis*, the number of brood cells was already significantly reduced after a mismatch of three days. *Osmia cornuta* produced the same number of brood cells after a mismatch of three days as under perfect synchronization, but the number of female offspring was significantly reduced. *Osmia bicornis* showed an increased death rate during the first days of life and a strongly decreased activity after a mismatch of three days. Nevertheless, they produced the same number of brood cells as under perfect synchronization, but spread them over fewer nests, which might increase the risk of parasitism and cause later fitness losses. In addition, the warmer the temperature during the experiment, the fewer individuals survived a temporal mismatch of three days in all species.

Our results show that even short temporal mismatches can cause tremendous fitness losses for wild bee species emerging in spring, especially for specialist wild bee species. In a variable world, e.g. under future global warming, this could have severe consequences for the persistence of these species.

O6 - Differing responses of wild bees and flowering plants to temperature might lead to temporal mismatches

Jonathan Lanzen[1], Andrea Holzschuh[1]

[1]University of Würzburg, Würzburg, DE, jonathan.lanzen@uni-wuerzburg.de

Climate warming could threaten the mutualistic interaction between wild bees and flowering plants by shifting the phenology of both interaction partners differently. Whether wild bee activity and plant flowering shift in parallel when temperature changes, is still largely unknown. Here we investigated in a large-scale field experiment how temperature affects the phenology of solitary bee species and associated plant species. We used 32 sites with different microclimates with a maximum difference in average temperature between sites of 4.8°C. We recorded hatching dates of six bee species, whose cocoons were experimentally established in artificial nests, and nesting dates of eight naturally occurring bee species that colonized trap nests at the same locations in one week intervals from March to September. The flower cover of 29 plant species was recorded in circles with 50 m radius around the trap nest in two week intervals during the same period. Our results show that the abundance-weighted mean date (WMD) of flowering and the first date of flowering were advanced in all plant species when the temperature was higher, whereas the end of the flowering period was not affected. Two bee species advanced the WMD and the first date of hatching, while one species shifted its WMD towards later when temperature was higher. The other three species did not respond to temperature. The first date of nesting was advanced in one species when the temperature was higher, while seven species did not respond. Higher temperature advanced the ending of the hatching period and postponed the ending of the nesting period. Our results show that there is a great variation among the phenological response of different bee species to temperature. To make accurate predictions on phenological shifts of wild bees it is crucial to investigate the mechanisms underlying these differences among species. The discrepancy in the timing of bees and plants, observed among most wild bees species and their potential food plants, could lead to temporal mismatches. These mismatches could result in reduced food resources for bees and a lack of plant pollinators and have great consequences for the fitness of both interaction partners.

O7 - Modelling the climatic turning point for European beech and sessile oak using national forest inventories

Klara Dolos[1], Tobias Mette[2], Sebastian Schmidtlein[1], Camilla Wellstein[3]

[1]Karlsruhe Institute of Technology, Karlsruhe, DE, dolos@kit.edu
[2]Bayerische Landesanstalt für Wald und Forstwirtschaft, Freising, DE
[3]Free University of Bozen-Bolzano, Bozen, IT

Forests of temperate Europe are climate sensitive ecosystems, and the current balance between the tree species will shift as climate becomes warmer and potentially drier. Especially changes in the dominant species have a strong impact on forest ecosystems because it fundamentally changes life conditions of plants and animals living in the forest. Mette el al. (2013) termed the climatic conditions at which a change in dominance occurs the "climatic turning point" (CTP). Backed up by empirical evidence, they used the forest growth models LandClim and SILVA to predict the CTP between European beech (*Fagus sylvatica*) and sessile oak (*Quercus petraea*) at an annual temperature of 11-12°C and a precipitation sum 500-530 mm/yr. This CTP suggests that beech is actually more drought tolerant than assumed by e.g. Ellenberg (1996). In the present study we show how the CTP can be derived from standardized systematic forest inventories and compare the results for the CTP between beech and oak from a joint data set of the national forest inventories of Germany, France and Spain.

O8 - Consequences of elevated temperature and soil compaction on the composition and biodiversity of an urban plant community

Conrad Schittko[1], Manfred Forstreuter[1], Susanne Wurst[1]

[1]Freie Universität, Berlin, DE, conrad.schittko@fu-berlin.de

Elements of global change, such as climate change, land use intensification, and biological invasions, are predicted to interactively impact the composition and functioning of plant communities, which may lead to new threats for biodiversity. However, few experimental studies have tested whether individual elements of global change interact synergistically in shaping plant communities and affecting ecosystem functioning. We present data from a mesocosm study in which we experimentally altered temperature and soil compaction to elucidate the differential responses of exotic and native plant species within an urban grassland community. Since the abiotic conditions may act as environmental filters, we conducted a trait analysis to determine which functional traits are responsible for the plant responses. Additionally, we investigated impacts of both factors on diversity, evenness, and functional trait diversity of the plant community. Elevated temperature and soil compaction had a negative and positive effect on community productivity, respectively, while no interactions between both factors were found. The responses were driven by the group of exotic plant species, while the group of native plant species remained unaffected. Species diversity, evenness, and functional trait diversity were positively affected by elevated temperature, but unaffected by soil compaction. Our results show that different elements of global change can have independent and contrasting rather than synergistic impacts on the productivity and biodiversity of a grassland community. Exotics were more sensitive to the altered environmental factors than natives which led in the case of elevated temperature to a decline of dominant exotics associated with an increase of the community's functional diversity.

P1 - The downward spiral: eco-evolutionary feedback loops lead to the emergence of `elastic' ranges

Alexander Kubisch[1,2], Anna-Marie Winter[3], Emanuel A. Fronhofer[4]

[1]University of Hohenheim, Stuttgart, DE, akubisch@posteo.de
[2]Université Montpellier II, Montpellier, FR, akubisch@posteo.de
[3]Centre for Ecological and Evolutionary Synthesis, Oslo, NO
[4]Eawag: Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, CH

In times of severe environmental changes and resulting shifts in the geographical distribution of animal and plant species it is crucial to unravel the mechanisms responsible for the dynamics of species' ranges. Without such a mechanistic understanding reliable projections of future species distributions are difficult to derive. Species' ranges may be highly dynamic. One particularly interesting phenomenon is range contraction following a period of expansion, referred to as `elastic' behaviour. It has been proposed that this phenomenon occurs in habitat gradients, which are characterized by a negative cline in selection for dispersal from the range core towards the margin, as one may find, for example, with increasing patch isolation. Using individual-based simulations and numerical analyses we show that Allee effects are an important determinant of range border elasticity. The eco-evolutionary interplay between dispersal evolution, Allee effects and habitat isolation leads to lower colonization probability and higher local extinction risk after range expansions, which result in an increasing amount of marginal sink patches and consequently, range contraction. We also demonstrate that the nature of the gradient is crucial for range elasticity. Gradients which do not select for lower dispersal at the margin than in the core (especially gradients in patch size, demographic stochasticity and extinction rate) do not lead to elastic range behavior. Thus, we predict that range contractions are likely to occur after periods of expansion for species living in gradients of increasing patch isolation, which suffer from Allee effects.

P2 - Tree fitness and climate change: reality check under field conditions

Barbara Moser[1], Lorenz Walthert[1], Marek Metslaid[1,2], Ulrich Wasem[1], Thomas Wohlgemuth[1]

[1]Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, CH, barbara.moser@wsl.ch
[2]Estonian University of Life Sciences, Tartu, EE

Bioclimatic models have been projecting almost uniformly a northward shift of European tree species as a result of rising temperatures and increasing duration of dry spells. Since it is not clear whether long-lived species will be able to keep track with rapidly changing climatic conditions, this has triggered a debate about the future management of temperate European forests and the pro-active facilitation of ecotypes from the dry end of current species ranges or more drought tolerant non-native tree species from southern Europe. For instance, results from greenhouse and common garden experiments suggest that Mediterranean populations of Scots pine (*Pinus sylvestris* L.) might be better adapted to the future conditions in Central Europe than autochthonous populations. At the same time there is growing evidence that spatial buffering, e.g. in terms of soil heterogeneity, has been widely underestimated in both climate change experiments and modelling studies.

In a field experiment set up at three south-exposed, low-elevation sites in the dry Alpine Rhine valley, Switzerland, we compared the establishment success and subsequent performance of *P. sylvestris* seedlings from dry regions in the Alps, the Mediterranean, and continental Eastern Europe under heterogeneous soil conditions and in years with differing weather conditions. We found that, independent of seed origin, regeneration was abundant in years with average to positive spring water balance only. Under these circumstances, autochthonous seedlings from Alpine regions outperformed those from most Mediterranean and Eastern European populations in terms of seedling emergence, survival, and growth by the end of the second growing season. In years with dry weather conditions in spring, regeneration success was similar among all populations. These results challenge the idea of mitigating climate change effects in temperate European forests by introducing non-native populations or tree species.

P3 - Effects of increasing temperature on invertebrate pests and beneficials

Thomas Frank[1], Nicole Auer[1], Martin Bramböck[1], Manuela Brandl[1],
Thomas Schwarz[1]

[1]Institute of Zoology, Department of Integrative Biology & Biodiversity Research, University of Natural Resources and Life Sciences Vienna, Vienna, AT, thomas.frank@boku.ac.at

For many regions of the world climate change in the form of increased temperature is predicted. The present project, which covers scenarios with increased temperatures under laboratory conditions, is designed for such regions, e.g. Eastern Austria. Experiments were conducted in three climate chambers at three different temperature regimes. The mean basis temperature (T1) was based on the mean temperatures of the last decades for Eastern Austria. For simulating future climate warming scenarios temperatures were increased by 3°C (T2) and 5°C (T3), therewith spanning the range of climate models for Eastern Austria. We studied the effect of temperature on 1) herbivory of slugs on oilseed rape (OSR), 2) predation of pollen beetles by carabid beetles, and 3) predation of aphids by lady beetles. The slug pest Arion vulgaris (=A. lusitanicus) killed significantly more OSR plants at T3 compared to T1. Deroceras reticulatum showed no clear pattern, i.e. in the first year there was no difference in the number of consumed OSR plants, however, in the second year the slug killed significantly more OSR plants at T2 than T1. Deroceras panormitanum consumed significantly more OSR plants at T2 and T3 compared to T1. In all experiments but one higher temperatures were shown to have a positive influence on slug herbivory. Therefore, it may be expected that climate warming will increase slug damage on OSR. The carabid beetles Amara ovata, Harpalus distinguendus and Poecilus cupreus killed significantly more pollen beetle larvae at T2 and T3 compared to T1. Anchomenus dorsalis killed significantly more larvae at T2 than T1, and Harpalus aeneus revealed no significant differences among temperatures. Biomass intake of A. ovata, H. distinguendus and A. dorsalis was significantly larger at T2 and T3 compared to T1, thus showing similar patterns as for killed larvae concerning the first two species. Biomass intake of H. aeneus and P. cupreus did not differ significantly among temperatures. Both the larval and adult lady beetles Adalia bipunctata, Coccinella septempunctata and Harmonia axyridis consumed significantly more aphids at T3 than T1 when consumption was related to coccinellid body weight. Overall, our findings on beneficial insects sound promising for biological pest control in regions where climate warming is to be expected.

P4 - Nutrient limitation increases sensitivity of algae towards silver nanoparticles

Asif Moinur Chowdhury[1,2,3]

Asif Moinur Chowdhury, Bremen, DE, asifmoinur@uni-bremen.de
[2]Yvonne Sakka, Bremen, DE, asifmoinur@uni-bremen.de
[3]Juliane Filser, Bremen, DE, asifmoinur@uni-bremen.de

According to the OECD guideline for the growth inhibition test with algae, the amount of nitrogen (3.927 mg/L) and phosphorus (0.285 mg/L) in the growth medium are more than twice (N) and three times (P) as high as on average in eutrophic lakes. In this study, the amount of either nitrogen or phosphorus in the medium was lowered from half to one-fourth of that of OECD guideline, resulting in five varieties: OECD, 50% N, 25% N, 50% P and 25% P. All other chemical components remained the same as suggested by the OECD guideline. Two freshwater micro-algae, *Pseudokirchneriella subcapitata* (PS) and *Desmodesmus subspicatus* (DS), were cultured in all media for 72 hours. The algae species were cultured both separately and together in all five mediums to observe if any competitive effect is present or not. An extra test was done to observe the growth inhibition of both algae species by silver nanoparticles (AgNP) as stressor. The growth of both species in OECD medium differed significantly from the other four media. The difference was less for 50% P but in the remaining three media the total number of both species was less than half compared to the OECD medium. No significant competitive effect between PS and DS was observed in any of the five media, as the average specific growth rates in mixed culture were similar as in separate cultures. In OECD medium PS was slightly more sensitive towards AgNP (EC_{50} = 52 µg Ag/L) than DS (EC_{50} = 58 µg Ag/L). With P and especially N limitation, the EC_{50} values sank up to only 15 µg Ag/L (DS with 25% N). This demonstrates that the OECD test guideline underestimates the risk of AgNP compared to more realistic situations.

P5 - Recovery of soil mesofauna (Collembola) communities of grassland after summer flooding

Odette Gonzalez Mace[1], Stefan Scheu[1]

[1]University of Göttingen, Göttingen, DE, ogonzal@gwdg.de

A large part of Germany was affected by a summer flood in 2013. This irregular flood strongly impacted grassland invertebrate communities reducing diversity, abundance and biomass of virtually all groups with the effects increasing with duration of flooding and temperature.

In grassland of different diversity (Jena Experiment) we analysed the recovery of the soil animal community by focusing on Collembola and taking repeated samples after flooding for more than one year. Collembola communities virtually got extinct by the flood but started to recover shortly thereafter. The effect of flooding on Acarina was less severe but recovery was slower.

The ability of soil animals to survive flooding depends on behavioural, morphological and physiological proprieties. The results suggest that Collembola are sensitive to flooding but also able to recover quickly due to high reproductive potential and dispersal ability. Whether their recovery varies with the composition of plant communities is currently investigated and will be presented.

P6 - Thermally polluted freshwater systems: A neglected opportunity to study multiple stressors in the face of climate change

Gregor Kalinkat[1,2], Emde Sebastian[3], Jonas Jourdan[3], Friedrich W. Miesen[4], Jonathan M. Jeschke[2,5], David Bierbach[2]

[1]ETH-Eawag, Kastanienbaum, CH, kalinkat@igb-berlin.de
[2]Leibniz-IGB, Berlin, DE, kalinkat@igb-berlin.de
[3]BiK-F, Frankfurt/M, DE
[4]ZFMK, Bonn, DE
[5]Freie Universität, Berlin, DE

Two of the major drivers of recent anthropogenic global change and biodiversity loss are rising temperatures and biological invasions. The strong interrelatedness of these two factors has been acknowledged repeatedly, and investigating synergies between them has been suggested. To date, however, studies addressing these calls have been sparse. We propose a new line of research that takes advantage of semi-natural experiments in long-standing thermally polluted freshwaters, i.e. systems influenced by thermal discharges of hot (or warm) water originating from anthropogenic sources such as power plants. Notably, we find levels of temperatures in such systems that correspond to future climate change projections. They might thus be used as models for future ecosystems. A growing number of recent studies confirm that such novel man-made conditions favor thermophilic organisms of alien origin. In some documented cases, species of tropical origin can even build sustainable and reproducing populations in thermally polluted freshwater habitats of temperate regions; the Gillbach within the Erft/Rhine catchment in western Germany is one prominent example. As the vast majority of existing studies of thermally polluted systems are restricted to descriptive approaches documenting diversity patterns, we emphasize the possibilities to examine the underlying mechanisms in comparative and experimental approaches, aiming to synthesize species interactions as well as community and ecosystem effects. We will present our views on-necessary and feasible research approaches, addressing the surge of thermophilic aquatic invaders in thermally polluted systems together with preliminary results from the Gillbach system. We believe that thermally polluted ecosystems provide unique possibilities to understand synergies between climate change and biological invasions, and hope the presentation will stimulate further discussion.

END OF SESSION 23

Session 24 - Movement ecology – a new research path for sustaining biodiversity and ecosystem functions

Short title: Movement ecology

CHAIRS: NIKO BALKENHOL, JOHANNES SIGNER

O1 - Integrating movement ecology with biodiversity research - exploring new avenues to address spatiotemporal biodiversity dynamics

Niels Blaum[1], Florian Jeltsch[1], Dries Bonte[2], Guy Pe'er[3], Björn Reineking[4], Peter Leimgruber[5], Niko Balkenhol[6], Boris Schröder[8], Carsten Buchmann[3], Thomas Müller[10], Katrin Böning-Gaese[10], Thorsten Wiegand[3], Jana A. Eccard[1], Heribert Hofer[11], Jette Reeg[1], Ute Eggers[1], Silke Bauer[13]

[1]University of Potsdam, Potsdam, DE
[2]University of Ghent, Ghent, BE
[3]UFZ – Helmholtz Centre for Environmental Research, Leipzig, DE
[4]University of Bayreuth, Bayreuth, DE
[5]Smithsonian, Conservation Biology Institute, Front Royal, US
[6]University of Göttingen, Göttingen, DE
[7]Technische Universität München, München, DE
[8]Technical University of Braunschweig, Braunschweig, DE
[9]University of Maryland, College Park, US
[10]Biodiversity and Climate Research Centre (BiK-F), Frankurt am Main, DE
[11]Leibniz Institute for Zoo and Wildlife Research (IZW), Berlin, DE
[12]Netherlands Institute of Ecology, Wageningen, NL
[13]Swiss Ornithological Institute, Sempach, CH

Movement of organisms is one of the key mechanisms shaping biodiversity, e.g. the distribution of genes, individuals and species in space and time. Recent technological and conceptual advances have improved our ability to assess the causes and consequences of individual movement, and led to the emergence of the new field of ‘movement ecology’. Here, we outline how movement ecology can contribute to the broad field of biodiversity research, i.e. the study of processes and patterns of life among and across different scales, from genes to ecosystems, and we propose a conceptual framework linking these hitherto largely separated fields of research. Our framework builds on the concept of movement ecology for individuals, and demonstrates its importance for linking individual organismal movement with biodiversity. First, organismal movements can provide ‘mobile links’ between habitats or ecosystems, thereby connecting resources, genes, and processes among otherwise separate locations. Understanding these mobile links and their impact on biodiversity will be facilitated by movement ecology, because mobile links can be created by different modes of movement (i.e., foraging, dispersal, migration) that relate to different spatiotemporal scales and have differential effects on biodiversity. Second, organismal movements can also mediate coexistence in communities, through ‘equalizing’ and ‘stabilizing’ mechanisms. This novel integrated framework provides a conceptual starting point for a better understanding of biodiversity dynamics in light of individual movement and space-use behavior across spatiotemporal scales. By illustrating this framework with examples, we argue that the integration of movement ecology and biodiversity research will also enhance our ability to conserve diversity at the genetic, species, and ecosystem levels.

O2 - Realised niches in a changing world: Temporal segmentation of animal trajectories by habitat use

Mariëlle van Toor[1]

[1]Max Planck Institute for Ornithology, Radolfzell, DE, mvantoor@orn.mpg.de
[2]University of Konstanz, Konstanz, DE

Recent advances and the reduced costs of tracking technology are providing ecologists with a wealth of animal tracking data. In addition to gaining insight into the mechanics of movement, migration patterns and space use, these data allow us to study the behaviour of individuals in high detail. By enriching trajectories with widely available environmental information, e.g. remote sensing data, we not only know about the movement and behaviour of individuals, but also the environmental conditions the individuals experienced. As individuals seeking to satisfy their physiological needs will likely try to optimise their movement, the available environment and its spatial utilisation by animals are inevitably linked. Moreover, changes in environmental conditions, and especially seasonal fluctuations, can be a main driver for movement and migration.

To be able to better understand the interactions between individuals and their environments, and how they influence the use of the available space, we developed a method to detect changes in these interactions and divide trajectories into behaviourally consistent segments. In order to assess and compare habitat use, we employed a species distribution modelling approach and verified it using simulations. Applying our method to tracking datasets of several waterbird species in Asia, we found that the realised niche of the studied indivuals could be robustly separated into different segments that are corresponding to major life history events of the species. We think that the segmentation of animal trajectories, and the derived models of species distribution, can open up the possibility to study the dynamics of species-environment interactions, and that the connectivity observed in temporally dynamic landscapes will give us the opportunity to broaden our understanding of when, where, and why animals move.

O3 - How to detect influences of environmental covariates on animal movement: a semi-variance approach

Johannes Signer[1], Otso Ovaskainen[2]

[1]Georg-August-University, Göttingen, DE, jsigner@gwdg.de
[2]University of Helsinki, Helsinki, FI

Movement is a fundamental process of an animal's biology. Recent conceptional advances suggest that the realized movement path of an animal is the outcome of an interplay of an animal's movement capacity, its internal state and external factors (e.g., environmental covariates). The movement capacity of an animal can influence many aspects of its biology (e.g., its distribution, habitat selection or genetic structure of populations). Understanding the influence of environmental factors on the movement capacity of an animal may be of interest for investigating basic and applied questions in (movement) ecology and conservation biology.

Recently a new semi-variance approach was introduced as a general method for analyzing animal movement data. The semi-variance approach is robust against irregular sampling and accounts for the autocorrelation in the data. Semivariograms have been used to distinguish between different movement modes (i.e., different models of home ranging behavior), but the effect of environmental covariates on movement has not been investigated with this method yet. We extend the semi-variance approach and test for the influence of environmental covariates on movement. We illustrate the method with a simulation study and data of a red deer population from Northern Germany.

O4 - Long distance movements in terrestrial mammals: perception versus memory

Chloe Bracis[1], Thomas Mueller[1]

[1]Senckenberg Biodiversity and Climate Research Centre & Department of Biological Sciences, Goethe University, Frankfurt, DE, cbracis@uw.edu

Long-distance movements allow animals to access alternate locations such as feeding opportunities or breeding locations and are key to ensuring the long-term survival of many species. In the case of long distance bird migration, research suggests a variety of navigational mechanisms, including perception and memory, either learned during an animal's lifetime or genetically inherited. Mechanisms underlying long-distance movements in terrestrial mammals, however, are significantly less studied. Most modeling efforts of the underlying drivers of mammalian land migration simply assume perception of favorable resources as the navigational mechanism. The possible role of memory that would allow mammals to forecast conditions at distant locations and times based on information about environmental conditions from previous years has generally not been considered. We seek to address the question of whether large-scale movements of land mammals are directed by perception, memory, or a combination of both. We do this by creating an individual-based model where foragers make movement decisions based on different movement processes including kinesis (movements guided by the current resource quality), perception (movements guided by current information within perceptual range), and memory (movements guided by memory for long-term average conditions throughout the population range). Perceptually-guided foragers probabilistically select a direction by spatially integrating currently sensed resource quality within their perceptual range. Memory-guided foragers also probabilistically select a direction, but integrate across their entire range using the forecasted long-term average quality at their predicted arrival time. We perform simulations of foragers moving through landscapes of time-varying resource quality and also fit the model to movement tracks of long distance movements of land mammals to reveal the underlying navigation mechanisms at work.

O5 - Mechanisms behind aggregation: Spatial memory use of an herbivorous leaf beetle and effects of predator hunting mode on clutch size

Jörg Stephan[1], Johan Stenberg[2], Christer Björkman[1]

[1]Swedish University of Agricultural Sciences, Department of Ecology, Uppsala, SE, jorg.stephan@slu.se
[2]Swedish University of Agricultural Sciences, Department of Plant Protection Biology, Alnarp, SE

Gregarious organisms face the trade-off that group living lowers predation risk but increases food competition with conspecifics. This is particularly important for ovipositing insects that decide how many eggs to lay in one clutch. Here we first investigate if the leaf beetle *Phratora vulgatissima* adjusts their own intra-plant egg clutch distribution to that of conspecifics. We secondly investigate whether the advantage of being in a large clutch depends on the predator hunting mode.

Like other herbivorous insects this beetle makes egg clusters by laying its clutches next to conspecific clutches on the same host plant (*Salix* spp.) individual. We first explore if females consider the distance to the next clutch during this oviposition site selection by releasing either the same female again, or a new female on the particular plant. We so discovered a new behavioural component, i.e. the increase of distances between clutches that should reduce intraspecific competition. The largest distance increases were observed on plants with their own compared to plants with clutches from conspecifics. Therefore, experienced females adjusted the distances in ways indicating the use of spatial memory because they could rely on perceived cues but also learned where they placed the previous clutches on that plant.

In the second investigation we exposed *P. vulgatissima* clutches of different sizes to either of two omnivorous predators. The more mobile predator *Anthocoris nemorum* exhibits a `run and eat' hunting mode and does not consume all discovered eggs. The other less mobile *Orthotylus marginalis* shows a `find and stay' foraging behavior and stays to consume all eggs found. We discovered that the `run and eat', but not the `find and stay' predator, selects for larger clutches. Therefore, the hunting mode affects survival even within a passive prey (eggs) group. Besides other explanations for larval grouping (thermoregulation, overcoming plant defence) we extend the explanation of protection against predators by introducing the importance of whether the predator consumes the whole clutch or not.

Both results, the adjustment of clutch distances using spatial memory and the difference in egg survival within large clutches due to the predator hunting mode, contribute to a better mechanistic understanding of aggregation in general.

O6 - A model-based approach to quantifying wildlife movement coordination

Justin M. Calabrese[1], Chris H. Fleming[1], Thomas Mueller[1,2]

[1]Smithsonian Conservation Biology Institute, Front Royal, US, CalabreseJ@si.edu
[2]Departement of Biological Sciences, Goethe University Frankfurt, Frankfurt, DE

While many animal species exhibit strong conspecific interactions, animal movement analyses still largely focus on single individuals. Wildlife tracking studies of multiple individuals provide new opportunities to explore movement correlation among individuals, thereby illuminating the mechanisms driving movement decisions and governing population-level distribution patterns. Here, we develop a general method for quantifying movement correlation that, unlike most existing techniques, is derived from an analytically tractable stochastic model of correlated movement. Our approach partitions correlation into a deterministic tendency to move in the same direction termed `drift correlation', and a stochastic component called `diffusive correlation'. These two components suggest the mechanisms that coordinate movements among individuals, with drift correlation indicating external influences (e.g., environmental gradients), and diffusive correlation pointing to social interactions. We illustrate the utility of our approach with two case studies on ungulates. First, we use an abrupt change in movement correlation to pinpoint the onset of spring migration in barren-ground caribou. Second, we show how spatial proximity mediates intermittently correlated movements among khulan in the Gobi desert. These examples demonstrate the potential of our approach as an exploratory analysis tool to both quantify correlated movements in tracking data, and suggest the type of mechanisms that generate the correlation.

O7 - An energetic landscape of fishers

Anne K Scharf[1,2], Scott LaPoint[1,2], Martin Wikelski[1,2], Kamran Safi[1,2]

[1]Max Planck Institute for Ornithology, Radolfzell, DE, ascharf@orn.mpg.de
[2]University of Konstanz, Konstanz, DE, ascharf@orn.mpg.de

Investigating animal energy expenditure across space and time may provide more detailed insight into how animals interact with their environment. This insight should improve our understanding of how changes in the environment affect animal energy budgets and is particularly relevant for animals living near or within human altered environments where habitat change can occur rapidly. We modeled fisher (*Pekania pennanti*) energy expenditure within their home ranges and investigated the potential environmental and spatial drivers of the predicted spatial pat-

terns. As a proxy for energy expenditure we used overall dynamic body acceleration (ODBA), which we quantified from tri-axial accelerometer data during the active phases of 12 individuals. We used a generalized additive model (GAM) to investigate the spatial distribution of ODBA by associating the acceleration data to the animals' GPS locations. We compared the spatial patterns of ODBA with the utilization distributions and habitat suitability estimates for each individual. The ODBA of fishers appears highly structured in space. However, we were not able to predict ODBA using the environmental data we selected. Additionally, ODBA estimates were not correlated with individual utilization distribution or with habitat suitability estimates. Our results suggest an unexpected complexity in the space use of animals that the classic concepts of home range and habitat suitability did not capture. We suggest future studies to recognize the limits of ODBA estimates which arise from the fact that acceleration is often collected at much finer spatio-temporal scales than the environmental data, and that ODBA lacks a behavioral correspondence. Overcoming these limits would improve the interpretation of energy expenditure in relation to the environment through additionally understanding the behavior-environment interface.

O8 - The movement ecology of Tetrahymena thermophila ciliates - linking individual cell movement to dispersal

Frank Pennekamp[1], Jean Clobert[3], Nicolas Schtickzelle[2]

[1]University of Zurich, Zurich, CH, frank.pennekamp@ieu.uzh.ch
[2]Université catholique de Louvain, Louvain-la-Neuve, BE
[3]Station d'Ecologie Experimentale du CNRS, Moulis, FR

Individual movement is a universal feature of animal life with wide implications for the ecology and evolution of species. Understanding the drivers of movement at the individual level and how it influences large-scale processes is a long-term goal in ecology. Variation in the movement phenotype of individuals can be influenced both by genetic and non-genetic sources and disentangling their effects is crucial for understanding the evolution of individual movement and its consequences at the population scale. Experimental studies of microscopic movement and resulting processes at the population level can provide such insights, but are so far rather rare.

We experimentally studied movement and dispersal using 44 genotypes of the actively dispersing unicellular, aquatic model organism *Tetrahymena thermophila*. We found significant variation in the movement behaviour associated to the genotype, but also the dispersal status. By using individual-based movement simulations we then show that movement and dispersal are tightly linked and strongly driven by genetic differences. However, including non-genetic differences such as the dispersal status considerably improved model predictions resulting in the full movement model accounting for more than 50% of variation in observed dispersal.

We will discuss the link between sources of variation in movement and dispersal, and how this may influence the dynamics of populations using the wider context of the movement ecology paradigm.

O9 - Movement patterns of nocturnal ground beetles in a grassland with manipulated plant diversity

Julia Tiede[1], Camille Zwaan[2], Teja Tscharntke[1], Christoph Scherber[1]

[1]Agroecology, University Goettingen, Goettingen, DE, jtiede@uni-goettingen.de
[2]Ecology and Evolutionary Biology, University of Boulder Colorado, Boulder, US

Plant diversity of terrestrial ecosystems is declining due to intensified land use. However, it remains largely unknown to what extent declining plant diversity affects movement patterns and activity of arthropods. To address this question, we combined direct individual based observations of the widespread and abundant ground beetles *Pterostichus melanarius* and *Harpalus rufipes* on a microhabitat scale with a mark-recapture approach. To assess movement pattern and activity of the beetles we used the framework of a grassland biodiversity experiment. We released 4 marked beetles per species beetles into 34 fenced plots (3.5 m x 1 m) covering a gradient of manipulated plant species richness (1-8 species). The beetles were previously marked with fluorescent paint, which glows brightly under UV light. During nightly observations the painted beetles were spotted with UV-flashlights and their movement traces were recorded. Further, the beetles were recaptured in dry pitfall traps that were attended daily and released again in the same plot.

Results suggest that individual movement pattern were affected by plant diversity, vegetation cover and gender. Further, vegetation cover had a negative effect on displacement between start and end point but only when plant diversity was low. In species poor plots with high vegetation cover lower displacement might indicate more favorable conditions compared to sparse cover. Trace length was higher for male individuals of both species. In contrast, recapture was mainly affected by beetle species: The mean time for the first recapture was 4 days for *P. melanarius* and 12 days for *H. rufipes*. Also, accumulated number of recaptures of *P. melanarius* were four times higher than of *H. rufipes*. In conclusion the results suggest that changing vegetation diversity is just one of several drivers of movement patterns and activity of ground beetles.

O10 - The importance of age and experience for population-level migration patterns

Thomas Mueller[1], Claire Teitelbaum[1], William Fagan[2], Bob O'Hara[1], Sarah Converse[3]

[1]Senckenberg & Goethe Univ., Frankfurt, DE, muellert@gmail.com

[2]University of Maryland, College Park, US
[3]USGS, Patuxent Wildlife Research Center, Laurel, US

In long-lived migratory species, migration patterns may change over time as individuals learn and optimize their route and site selection; furthermore, in social species that travel in groups, experienced individuals may transfer information to younger, less experienced birds. We took advantage of life-time migratory data from a reintroduced population of whooping cranes to assess the relative importance of genetic, environmental, social, and individual factors in determining migration patterns. Whooping cranes are a long-lived social species of conservation concern; the Eastern Migratory Population (EMP) is a reintroduced population where year-old birds are trained to migrate by following an ultralight aircraft and each individual is monitored over its entire lifetime, yielding an extensive dataset of movement and demographic data. We examined the migratory performance of individuals as well as changes of migratory patterns in the EMP over time, as related to characteristics of individual birds, characteristics of flight groups, and environmental conditions. We found that migratory performance of individuals were influenced by social learning and were best predicted by the age of the oldest bird in a migratory group. We also documented a clear change of migratory patterns over time with a northward trend of overwintering sites and a reduction of migration distance from 2002 to 2013 of about 900 km. The strongest predictor of migration distance of newly innovated overwintering sites was the age of birds, with each year of age associated with up to 200 km decrease in migration distance. In contrast to other reports of changing migration strategies over time, we found no effect of temperature on migration distance. Our results show that in social species, migration strategies are innovated and learned over time and are transmitted from older to younger individuals in a population.

P1 - How to catch different types of dispersed pioneer tree seeds in open areas successfully

Katharina Tiebel[1], Franka Huth[1], Sven Wagner[1]

[1]TU-Dresden, Institute of Silviculture and Forest Protection, Chair of Silviculture, Tharandt, DE, Katharina.Tiebel@forst.tu-dresden.de

Storm events, insect calamities or snow breaks are causes of large-scale disturbances in Norway spruce and Scots pine forests in Germany. In most cases the damaged forest are reforested after such events. However natural disturbances provide the opportunity to convert these unstable coniferous forests to stable, unevenly-aged mixed stands. Due to their species-specific characteristics, pioneer tree species can (1) regenerate rapidly, (2) colonise large areas and thus reduce erosion of exposed soil, (3) act as long-term stabilizing structural elements and (4) enhance forest biodiversity in the new forest generation.

However, the knowledge of maximum seed dispersal distances, seed densities on disturbed areas and required minimum seed tree densities necessary for successful regeneration establishment are often insufficient. Often, the lack of appropriate methods for sampling the small seeds of pioneer tree species in space and time makes it difficult to acquire such information. One means of overcoming this problem is to adapt seed trap systems for different seed dispersal mechanisms like anemochory or zoochory. Differences in seed morphology make it necessary to use different types of seed traps.

Therefore we discuss the functionality and the spatial arrangements of different seed trap systems for pioneer tree species like *Betula* ssp., *Salix* ssp. and *Sorbus aucuparia* LINNÉ. (i) Funnel-shaped net seed traps were used for wind dispersed seeds of birch species after modification to account for the stronger wind regime. (ii) The wind-dispersed willow seeds (1 - 1.5 mm) are smaller than birch seeds (2.5 - 3.5 mm). Thus a sticky, non-drying substance was needed to catch the seeds and prevent their loss by wind. (iii) For rowan seeds dispersed by birds, clothing textiles were used, which were fixed with hooks on the soil surface.

P2 - Connectivity from a different perspective: comparing seed dispersal in connected vs. unfragmented landscapes

John D. Herrmann[1,2,3], Tomás A. Carlo[4], Lars A. Brudvig[3], Ellen I. Damschen[6], Nick M. Haddad[5], Douglas J. Levey[7], John L. Orrock[6], Joshua J. Tewksbury[2]

[1]Christian-Albrechts-Universität zu Kiel,, Kiel, DE, eco.herrmann@gmail.com
[2]University of Washington, Seattle, US, eco.herrmann@gmail.com
[3]Michigan State University, East Lansing, US, eco.herrmann@gmail.com
[4]Pennsylvania State University, State College, US
[5]North Carolina State University, Raleigh, US
[6]University of Wisconsin–Madison, Madison, US
[7]University of Florida, Gainesville, US

Habitat fragmentation can create significant impediments to dispersal. A technique to increase dispersal between otherwise isolated fragments is the use of corridors. Yet, the extent to which corridors restore levels of dispersal to those occurring in unfragmented landscapes remains unknown because previous studies have compared dispersal between connected fragments to dispersal between unconnected fragments, not dispersal between connected fragments and dispersal within unfragmented landscapes. To test for the extent to which corridors restore dispersal found in unfragmented landscapes, we compared seed dispersal patterns among four unfragmented landscapes and eight landscapes with experimentally corridor-connected fragments. We used two wind- and two bird-dispersed plant species to examine whether responses varied by seed dispersal mode. We constructed dispersal kernels for these species in unfragmented landscapes and corridor-connected fragments by using ^{15}N isotopes to mark seeds in the center of each landscape and recovering marked seeds in seed traps at distances up to 200 m. For the two wind-dispersed plants, seed dispersal kernels were similar in unfragmented landscapes and corridor-connected fragments. In contrast, dispersal kernels of bird-dispersed seeds were affected by fragmentation, but differed between species: *Morella cerifera* experienced more and *Rhus copallina* less long-distance dispersal in unfragmented than in corridor-connected landscapes.These results suggest that corridors can restore dispersal probabilities to those of unfragmented landscapes, but also highlight that this effect varies among species in ways that may be related to dispersal traits.Our findings also highlightthe feasibility and utility of using community-level marking techniques for simultaneous quantification of dispersal dynamics of multiple species.

P3 - Capturing the complexity of animal movement: the Behavioral States Walk

Myriam Hirt[1]

[1]iDiv, Leipzig, DE, myriam.hirt@idiv.de

The emerging desire to understand and analyze the movement of animals clearly emphasizes the need for walk models that create realistic movement patterns of animals in the wild. These models should provide a conceptual bridge between natural movement data and the behavioral mechanisms behind them. The main classical random walk models in ecology comprise Brownian motion, correlated random walks and Levy walks. However, these classical random walk models are highly restricted as they can always depict only one behavior at a time. It is quite obvious that animal movement is far more complex than these models assume and that it is essential to take into account changes in movement behavior as well as heterogeneous environmental conditions. Thus, there is still a large gap between the current theoretical framework and its ecological applicability. This gap shall be filled by introducing a new random walk model called the Behavioral States Walk (BSW). The basic idea of the BSW is to create a flexible model of animal movement that allows to account for variance in landscape characteristics and species parameters. The landscapes are described by the degree of fragmentation and the patch size. Species traits comprise body size, life history and strategy and movement mode. The interplay between these characteristics determines shifts among behavioral states of animals. Up to now, the model assumes foraging, dispersal and migration as the basic behavioral states. The combination of these behavioral states leads to a completely new type of complex trajectories that help to draw a realistic picture of animals moving in the wild. Thereby, the BSW facilitates a deeper mechanistic understanding of how species and landscape parameters interactively affect movement of animals in real landscapes.

P4 - Modeling movement and landscape effects on ground-beetle diversity

Sebastian Hanß[1], Kerstin Wiegand[1], Tobias Purtauf[2]

[1]Department of Ecosystem Modelling, Georg-August-University of Göttingen, Götingen, DE, sebastian@hanss.info
[2]Department of Animal Ecology, Justus-Liebig University Gießen,, Gießen, DE

While there is a broad agreement that landscape degradation like habitat loss, isolation and fragmentation does influence biodiversity, the actual processes are still poorly understood.

To study the effects of the two most basic landscape properties, composition (how much habitat) and configuration (spatial arrangement, connectivity) on biodiversity, we developed a spatially-explicit simulation model with 21 artificial ground-beetle species (Coleoptera). In our simulation experiments we measured species frequencies on artificial landscapes with varying landscape composition and configuration.

The species mainly differ in habitat specificity, movement ability, and persistence of local subpopulations. The population dynamics is modeled with a metapopulation approach. Animal movement (dispersal) however, is individual-based and follows the idea of an optimal search strategy (adaptive Levy Walk).

The parameterization of the model is based on field data and expert knowledge. Results of the simulation experiments support the following hypothesis: (1) Habitat arrangement has a high influence on the frequency of less mobile species. (2) Highly mobile species' frequencies are determined by landscape composition, only.

Land-use changes accompanied with habitat loss and fragmentation can therefore impact less mobile species merely due to changes in spatial habitat arrangement.

P5 - Critical interaction between forest plants and corridor properties during the step-by-step dispersal in agricultural landscapes

Taavi Paal[1], Jaan Liira[1]

[1]Institute of Ecology and Earth Sciences, University of Tartu, Tartu, EE, taavi.paal@ut.ee

Woody corridors in fragmented landscapes have been proposed as dispersal enhancing landscape elements or as surrogate habitats for forest plants. Our aim was to define ecological filters limiting forest specialist plants dispersal into and along corridors. We sampled 50 forest–corridor transects in agricultural landscapes of southeastern Estonia. We extracted limiting drivers by searching for trait convergence between forest specialists and two habitat generalist groups (forest generalists and common corridor plants) and building a prediction model of forest-specialists migration distance. We found that species richness and the proportion of forest specialists decreased sharply from forest interior to first meters of corridor while species richness of generalists remained constant. Species occurrence was mainly associated with traits related to establishment and environmental tolerance. Light conditions were important for both species groups in corridors, while corridor age and width supported specialists and suppressed generalists. The results indicate that dispersal-related traits had a low functional role in plant migration into corridors. We conclude that most woody corridors are only stepping-stone habitats for habitat generalist species, and not for forest specialists.

END OF SESSION 24

Session 25 - Forest Ecosystems: How are forest structures linked to specific ecosystem services?
Short title: Forest Structures and Ecosystem Services

CHAIRS: FRANKA HUTH, SVEN WAGNER, UTA BERGER

O1 - Can forest management make use of robust functional links between ESS, traits, and structural elements in forests?

Sven Wagner[1], Franka Huth[1]

[1]Institute of Silviculture and Forest Protection, Dresden University of Technology, Tharandt, Dresden, DE, wagner@forst.tu-dresden.de

Linking management goals and forest structure essentially makes deterministic use of a functional chain between forest structure, its associated traits and the resulting forest products or services. Thus the structure of forests reflects the intended use of its owner. Although specific forest structures determine different ecosystem services (ESS), the provision of multiple services can cause conflicts between different stakeholders. As different structural elements cannot occupy the same site simultaneously, there is competition for available space; e.g. structural retention and old-growth stands *versus* highly productive pole stage of conifers. Otherwise the correspondence among forest structures used for optimal, service-specific forests offers the opportunity of synergies when aiming for multiple-use forest management.

The literature as well as examples from practical experience shows that this deterministic concept has been applied in biodiversity, recreation and freshwater management. The deterministic concept involves defining the maximum probability of occurrence of an intended outcome linked to a given forest structure. This probability of occurrence (i) is often assessed as being too low when aiming for specific forest services (e.g. habitats), thus (ii) additional specific measures are necessary to achieve a high quality provision of these services, and further, (iii) the success of those measures needs to be assessed in management for ESS.

ESS have been studied at varying intensities for the different ESS categories. Sometimes, it is not the links between forest structure and ESS, but those between structural elements and traits which have been studied. Due to the considerable differences in the quality of information about the links mentioned above, the spatial and temporal predictability of desirable forest structures as well as the resulting services are considered by many forest enterprises to be insufficient, e.g. in recreation forests.

O2 - Biomass stock and net primary production (NPP) of virgin forests and managed stands compared: a study at three sites in Slovakia

Jonas Glatthorn[1], Eike Feldmann[1], Markus Hauck[1], Stefan Kaufmann[1], Christoph Leuschner[1]

[1]University of Göttingen - Plant Ecology and Ecosystem Research, Göttingen, DE, jglatth@gwdg.de

How much biomass can potentially be stored in a beech forest and how much biomass is sequestered per year? How big is the influence of management on carbon stock and productivity? Virgin forests are the best available benchmarks about the natural capabilities of forested landscapes. To get new insights into the topic, we inventoried the aboveground biomass stocks and net primary production (NPPa) of three beech virgin forest relics in Slovakia (58 ha, 1.7 km^2, 7.6 km^2) and in close-by managed beech stands close to final harvest on comparable sites.

We found live aboveground tree biomass stock averages of 411 Mg ha^{-1} in the virgin forests and of 312 Mg ha^{-1} in the managed forests, which is 25 % less on average. However, variation among the managed stands was considerable. The dead biomass was with on average 70 Mg ha^{-1} 8.4 times larger in the virgin forests than in the managed stands (8 Mg ha^{-1}). Total biomass stocks (live and dead) were by 33 % larger in the former (480 vs. 320 Mg ha^{-1}). It is frequently assumed that managed forests do have a higher productivity than virgin forests because foresters remove non-vital trees and improve the overall growing conditions for the remaining trees in the forest. This could not be confirmed by our data. The NPPa of virgin and managed stands was similar in 2014.

O3 - Trade-offs between climate change adaptation and mitigation objectives for forests in south-western Germany

Somidh Saha[1], Jürgen Bauhus[1]

[1]Chair of Silviculture, University of Freiburg, Freiburg i. Br., DE, somidh.saha@waldbau.uni-freiburg.de

The carbon stocks in German forests are at a historically high level. Yet, there are demands to store more carbon in forests as a climate change mitigation strategy. It is also generally agreed that species and structural diversity of forests should be increased to improve their resistance, resilience and adaptability in the face of climate change. However, these different goals of climate change mitigation and adaptation may not always be compatible. Important trade-offs may exist, if the conditions that maximize biomass do not support high levels of species and structural diversity. Here, we aimed to quantify benefits and trade-offs between the mitigation (i.e. standing biomass, biomass increment) and adaptation objectives (i.e. structural and species diversity) for a wide range of forest types. For example, the benefit for an objective at a given inventory plot was quantified as the relative deviation from the mean for a given forest type. The trade-off for one objective was defined as the standardized difference from the overall benefits of all objectives for that forest type.We synthesized data from the first, second and third national German forest inventories to capture the changes in trade-offs between the management objectives over space and time by performing Bayesian generalized linear mixed models. Benefits and trade-offs between objectives were influenced by harvesting intensity, forest composition, tree size, and species identity. Mixed forests had higher benefits in species diversity but also high trade-offs between diversity and stand biomass. In contrast, forests dominated by a single species showed the opposite trend. Benefits in structural diversity increased with average tree size, however, the influence of tree size on benefits in biomass and species diversity varied between tree species and harvesting intensity. We show for the first time, that significant trade-offs exist between climate change adaptation and mitigation through ecosystem-based C storage objectives for German forests. Our study will help to optimize forest management related to climate change adaptation and mitigation.

O4 - The „interaction“ of deadwood and bryophytes from an ecosystem service perspective

Ulrike Hagemann[1]

[1]Leibniz Centre for Agricultural Landscape Research (ZALF) e.V., Müncheberg, DE, ulrike.hagemann@zalf.de

From the perspective of habitat provision and forest biodiversity, deadwood is one of the most intensively studied forest ecosystem structures, and often used as a seemingly simple indicator of forest biodiversity. Moreover, deadwood has also been recognized for its contribution to other forest ecosystem services (ESS) like nutrient cycling, carbon cycling and storage, primary production (via the facilitation of forest regeneration), and, to a lesser extent, soil formation. Numerous individual deadwood traits like woody species, size, wood density and chemistry, age, position, and others have been analysed with respect to their relevance for the processes underlying the provisioning of these ESS – albeit not always from the trait-service perspective.

However, the quality of the ESS delivered by deadwood not only depends on the functional traits of the deadwood itself, but also on the “interaction” of deadwood with a small and often overlooked ecosystem component: bryophytes. In forest types with a dominant herb or shrub layer or a solid layer of deciduous leaf litter, bryophyte microhabitats are often almost completely restricted to the surface of logs and stumps. In many coniferous forests, bryophytes typically dominate the ground vegetation layer, more or less rapidly overgrowing all downed deadwood. The presence of live bryophytes on the surface of deadwood modifies or interacts with the inherent deadwood traits, and can therefore have considerable effects on processes underlying the above-mentioned deadwood-associated ESS.

Drawing on a range of field data and literature on various aspects of the association between deadwood and bryophytes, I will explore and discuss the relevance of this association for two selected ESS: i) climate regulation (ESS) through carbon cycling and storage (process), and ii) primary production (ESS) through forest regeneration (process).

O5 - Structural diversity promotes tree growth in uneven-aged, mixed coniferous forests

Adrian Danescu[3], Axel Albrecht[3], Ulrich Kohnle[3], Jürgen Bauhus[4]

[3]Forest Research Institute of Baden-Württemberg, Freiburg im Breisgau, DE, adrian.danescu@ymail.com
[4]Faculty of Environment and Natural Resources, Freiburg University, Freiburg im Breisgau, DE

Increasing the structural and species diversity are silvicultural measures expected to enhance ecosystem functioning and the adaptive capacity of forests to climate change. However, studies concerning the impact of stand structural diversity on ecosystem functioning are rare and have not yet provided consistent results.

In our study we considered the forest function of wood production and we tested, if structural or species diversity influenced tree basal area increment while controlling for other growth-relevant factors (e.g. competition, stand density, site quality). Data from 52 long-term experimental plots in southwestern Germany were used for calibrating and evaluating growth models for fir, spruce and beech. Linear mixed-effects models at the tree level indicated that (1) structural diversity (measured with non-spatial indices) had a clear positive effect on tree increment, (2) this effect was best quantified by different indices for the three species, and (3) species diversity was not statistically significant. Additional results were obtained in relation to climatic variables, i.e. the mean annual temperature and growing season precipitation positively affected wood production (yet the magnitude differed among species, e.g. spruce was more severely affected by water availability in the growing season than fir).

Our analysis provides evidence that managing forest stands for structural diversity enhances wood production. It also indicates that tree species diversity effects on productivity reported in previous studies may have been partially attributable to stand structural diversity.

O6 - Effects of intensity of forest regeneration measures on some ecosystem services in a nationwide Swedish field experiment

Kristina Ahnlund Ulvcrona[1], Göran Hallsby[1], Charlotta Erefur[1], Urban Bergsten[1,]
[1]SLU, Umeå, SE, kristina.ulvcrona@slu.se

Effects on important ecosystem services (total and species-wise biomass production, distributed on tree fractions), of three regimes with different intensities of forest regeneration measures after clear-cut where evaluated 24-27 years after initiation of a field experiment at 14 sites across Sweden. the three treatments designed high (HI), normal (NI) and low (LI) respectively concisted of: mechanical site preparation and planting of large seedlings at 2 x 2 m spacing, with supplemental planting and pre-commercial thinning when needed; standard local practices; and natural regeneration with no site preparation, artificial planting or PCT.

Over all, significantly more total biomass was found in the HI (53.6 ton ha^{-1}) and NI (40.8 ton ha^{-1}) treatments compared to the LI (23.5 ton ha^{-1}) treatment. For stem biomass, significant differences were found only between the HI and LI (37.0 and 16.5 ton ha^{-1}respectively) treatments, and the same results was also found for living branches; HI (8.2 ton ha^{-1}) and LI (5.3 ton ha^{-1}). For foliage, the two managed treatments had significantly higher values 7.5 ton ha^{-1} (HI) and 6.3 ton ha^{-1} (NI) compared to 3.0 ton ha^{-1} for the LI treatment. Also for dead branches the highest values was found in the HI treatment (3.3 ton ha^{-1}), significantly higher compared to the LI treatment (0.7 ton ha^{-1}).

In addition to effects on biomass production and allocation, the regeneration intensity also influenced stand structure and composition. Hence, regeneration intensity may effect biodiversity, ecosystem functions and social values in a number of different ways.

O7 - Effects of forest management on functional diversity of fungi during forest conversion in the Eifel National Park

Peggy Heine[1], Jonas Hausen[1], Jürgen Prell[2], Richard Ottermanns[1], Martina Roß-Nickoll[1]

[1]Institute for Environmental Research (Biology V), RWTH Aachen University, Aachen, DE, peggyheine@bio5.rwth-aachen.de
[2]Institute of Biology I (Botany/Molecular Genetics) – Lab for Soil Ecology, RWTH Aachen University, Aachen, DE

Fungi provide essential functions and services in forest ecosystems by decomposing organic material, acting as parasites, and developing mycorrhizal associations. In natural ecosystems these functional networks are well established and ensure stability and resilience of complex forest systems. Due to these characteristics, fungal communities and its functions are a sensitive indicator for influences of forest management.

Currently, many German forests consist of planted Norway spruce stands, although the potential natural vegetation is predominantly wood-rush-beech forest. The Eifel National Park applies forest conversion of spruce stands into beech forests within management strategies. In our study, ecological effects of forest management on composition of fungal communities and functional diversity are studied using a space-for-time substitution design.

Different forest management stages (conventional spruce, managed and unmanaged wind throw, spruce with underplanted beech trees) and near-natural beech forest reserve (3 replicates each) were selected. Fungal fruiting bodies for taxonomic identification, and soil samples were collected. Various environmental factors such as C/N, pH or climatic conditions were measured.

337 fungal species were observed during field surveys. Near-natural beech forests showed the highest fungal diversity. Gradient analyses of species composition displayed distinct fungal communities for all conversion stages. Group analyses revealed more complex functional diversity for beech forest than for the other stages. This work demonstrates strong influence of current management strategies on fungal community compositions and its functions. We conclude that the currently applied methods of forest conversion have considerable consequences for the ecosystem. Future work will focus on combination of morphological results with fungal DNA barcodes detected by high-throughput sequencing to generate more comprehensive picture of the fungal communities.

O8 - The link between tree diversity and foliar fungal pathogens

Lydia Hönig[1]

[1]MLU Halle-Wittenberg, Halle, DE, lydia.hoenig@botanik.uni-halle.de

How could forest structures affect habitat availability for foliar fungal species as well as regulation services by foliar fungal diseases? Trees in all forest settings are exposed to infections by leaf microfungi, which are able to harm and weaken their hosts via diminishing photosynthesis and removing nutrients. Since most foliar fungal pathogens exhibit a narrow host range, fungal species richness is expected to accumulate with increasing host richness. Furthermore, leaf fungi need specific microclimatic conditions to infect a host and to develop within their specific microhabitat. Thus, high local tree diversity may offer more heterogeneous microclimatic niches and might result in higher fungal species richness. In contrast, high tree diversity is expected to reduce fungal infestation, since fungal transmission is less effective with increasing distance among host individuals and barrier effects by nonhost tree individuals.

Since 2010 leaf microfungi have been macroscopically and microscopically screened by using leaves and needles of different tree species from several tree diversity experiments in temperate and boreal Europe as well as subtropical China.

Intra-specific and inter-specific tree diversity effects on fungal species richness as well as fungal infestation have been analysed, thereby considering different aspects of inter-specific diversity: tree species diversity, tree functional diversity and tree phylogenetic diversity. In addition, host density and non-host neighbour effects have been taken into account.

First, I will demonstrate the effectiveness of particular forest structures regarding the habitat availability for foliar fungal species as well as the regulation of fungal diseases. Second, I will point on the impact by the studied forest settings focus as well as spatial and time scales restricting the generality of the results. Finally, I will emphasise the importance to maintain tree diversity for sustaining these two ecosystem services.

O9 - Tree diversity enhances stand productivity but has no effect on leaf area index in subtropical forest

Nadia Castro-Izaguirre[1], Xiulian Chi[2], Zhiyao Tang[2], Martin Baruffol[1], Bernhard Schmid[1], Pascal A. Niklaus[1]

[1]University of Zurich, Zurich, CH, nadia.castro@ieu.uzh.ch
[2]Peking University, Beijing, CN

Observational studies have shown that woody production increases with tree species richness (SR) in forest, from subtropical to boreal ones. In contrast, little is known about the effect of SR on leaf area production, where primary production takes place.

Stand leaf area is expected to increase with SR as a result of a more complete canopy space use in more diverse stands, where species vary in shade tolerance and growth characteristics. In fact, light partitioning has often been proposed as a mechanism explaining effects of SR on plant productivity.

Here, we tested effects of tree SR on canopy structure (SD of tree height as a proxy of canopy space filling, SDheight) and a set of variables related to primary productivity - LAI, stand basal area (SBA) and aboveground biomass carbon content (C-content) – in a mixed broad-leaved forest in subtropical China. In 2008 and 2012, we measured the diameter at breast height (DBH) and height of all trees with DBH>10 cm and took hemispheric photographs in 25 plots which were selected to span gradients in tree SR and stand successional age. To test the effect of SR on response variables, we used general linear models. To further analyze the relationship between diversity (SR, phylogenetic and functional diversity), successional age and tree density, we used structural equation models.

We found that as SR increased, SDheight, SBA, ΔSBA2008-2012, C-content, ΔC2008-2012 went up. The increase in SBA, ΔSBA and C-content in more diverse plots was driven by both larger numbers of trees and larger individual size and growth. In contrast, the effect of diversity on ΔC2008-2012 was driven only by an increase in

tree density. Successionally older plots had higher SBA but lower ΔSBA and ΔC2008-2012, whereas C-content was not affected by stand age. Surprisingly, LAI, either in spring or summer, was not affected by SR, stand age or tree density.
Overall, our study confirms that tree diversity promotes forest productivity during secondary succession. Although more diverse stands could fill the canopy vertical space more completely and achieved higher SBA and C-contents, we did not detect any effect on LAI. Our results suggest then that either more diverse stands achieve a better light use efficiency or that processes other than light partitioning might be responsible for the effect of SR on productivity.

O10 - Assessing tropical forest restoration success using functional diversity indices

Markus Engel[1], André Lindner[1], Uta Berger[1]

[1]TU Dresden, Dresden, DE

Assessing the restoration success in reforested areas of the Atlantic Forest in SE Brazil is of outstanding importance since this biome is mostly devastated and fragmented. Instead of the usual considerations of biomass accumulation, carbon storage and biodiversity enhancement, we suggest using functional diversity as another perspective to assess reforestation success. We used data on species diversity and abundances within the reforestation from 2008, 2011, and 2013, differentiating between sloped and plane areas. We investigated the influence of the time since reforestation and small-scale relief differences on functional diversity which we based on functional and performance trait assessments of the occurring species at every age of the reforestation. We calculated functional diversity indices for every species community and compared them to indices based on a null model for species abundances and species trait space. The functional richness increased remarkably due to immigrating species dispersed by wind and, most importantly, animals from forest remnants into the reforestation. The zoochorous seed dispersal syndrome appears to be an important mechanism driving the structural and functional characteristics of the reforestation. Especially the species community of the forest remnant shows a distinct deviation from random expectation which indicates a strong environmental filtering effect on species assembly. This effect can be observed in the reforestation as well but to a lesser extent. Using functional diversity indices as a measure to evaluate the restoration success proved to be valuable but restrictions arouse concerning the quality and extent of the functional traits assessment. We, therefore, recommend intensifying trait measurements especially on functional leaf traits and including belowground components of functional diversity which will considerably alter the results.

P1 - Canopy gap and regeneration dynamics in a beech virgin forest in Slovakia

Eike Feldmann[1], Jonas Glatthorn[1], Lars Drößler[2], Stefan Kaufmann[1], Markus Hauck[1], Christoph Leuschner[1]

[1]Plant Ecology and Ecosystem Research, Albrecht-von-Haller Institut for Plant Sciences, University of Göttingen, Göttingen, DE, efeldma1@gwdg.de
[2]Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Alnarp, SE

The few remaining virgin forest remnants in Central Europe are suitable study objects for analyzing natural disturbance regimes in temperate broad-leaved forests. We studied canopy gap distribution as an expression of disturbances in a 53 ha beech (Fagus sylvatica L.) virgin forest relic in Slovakia in 2003 and 2013 using line intersect sampling. The size development of gaps from 2003 was documented and the processes of gap closure were analyzed. In 2013, we inspected tree regeneration in all canopy gaps encountered in both of the years.

The percentage gap area decreased from 13.6 % of the forest area in 2003 to 8.2 % in 2013. There was an exponential decrease in frequency of gaps with increasing gap size in both years. In 2003, large gaps > 1000 m² account for 50 % of the gap area, while in 2013 no gaps > 1000 m² were encountered. In 2013, small gaps < 100 m² dominated with 44 % of the gap area. 95 % of the gaps from 2003 decreased in size and 1/3 of them had been closed in 2013. Crown expansion of bordering canopy trees was the main closure process in most small gaps, while in larger gaps there was a remarkable recruitment to the canopy layer from lower strata. Most gaps showed several regeneration periods resulting in different regeneration layers. The area of old and new gaps had a similar regeneration cover of about 60 %. However, in new gaps the percentage cover was highest in the lowest stratum (<2 m), whereas in old gaps the maximum was in the next higher stratum (2 - 10 m).

The results show that this virgin forest experienced a strong temporal variability in disturbance intensity. Small gaps were present in high numbers in both studied years, but they are likely to be closed by crown expansion soon. Thus, the growing conditions for beech regeneration are only improved for a short period of time by these small gaps. Rarely occurring large gaps can reach a high areal proportion and enable the recruitment of regeneration to the canopy.

P2 - Drivers of oak tree selection by acorn-harvesting jays

Gabriel Gerzabek[1], Arndt Hampe[1]

[1]UMR 1202 Biogeco, Bordeaux, FR, gerzabek@pierroton.inra.fr

The Eurasian jay (*Garrulus glandarius*) is the most prominent seed disperser of oaks (*Quercus* spp.) in Europe. Jays commonly harvest and store thousands of acorns in a single fruiting season. Their decision on which oak tree to harvest can hence have important consequences for the dispersal success of individual trees, eventually shaping their reproductive output and the resulting genetic composition of recruiting plants. Yet quantifying tree selection by acorn-harvesting jays is an extremely challenging task, consequently very little is known about the underlying mechanisms.

We investigate the acorn dispersal success of individual trees in a small Pedunculate oak (*Q. robur*) stand and relate it with tree features hypothesized to influence the behavior of acorn-harvesting jays. We mapped and genotyped all adult trees (n = 252) of the stand and measured their dbh. We also measured the height, fecundity, and acorn size in a sub-sample of 80 individuals. During the period of seedling emergence, we mapped and collected >800 newly germinated seedlings, a sample that approaches the totality of individuals stemming from acorn dispersal events in the study area and year. Seedlings were also genotyped and their parents were identified by means of parentage analysis.

Only a handful of trees produced a large number of dispersed acorns while the majority of trees in the stand contributed very little or nothing to regeneration. We found evidence for a positive crop size effect on tree selection by the jay based on the significant positive correlation between the number of seedlings stemming from acorn dispersal events and dbh on the one hand, and fecundity on the other hand. Our results show that jays can exert a strong effect on the contribution of individual oak trees to population-level recruitment. They underpin that combined molecular and field ecological approaches have a great potential for addressing the role of dispersal agents in the recruitment and regeneration of animal-dispersed plant populations.

P3 - Dispersal limitation drives successional pathways in Central Siberian forests under current and intensified fire regimes

Susanne Tautenhahn[1], Martin Jung[2], Jeremy W. Lichstein[3], Stephanie A. Bohlman[4], Hermann Heilmeier[5], Anatoly Prokushkin[6], Jens Kattge[2], Anja Kahl[7], Christian Wirth[7]

[1]Plant Biodiversity Group, Institute of Special Botany, FSU Jena, Jena, DE, susanne.tautenhahn@uni-jena.de
[2]Max-Planck-Institute for Biogeochemistry, Jena, DE
[3]University of Florida, Department of Biology, Gainesville, US
[4]University of Florida, School of Forest Resources and Conservation, Gainesville, US
[5]TU Bergakademie Freiberg, Department of Biosciences, Freiberg, DE
[6]Sukachev Institute of Forest, Siberian Branch, Russian Academy of Sciences, Krasnoyarsk, RU
[7]University of Leipzig, Leipzig, DE

Fire is a major control of regeneration in the boreal forests of Central Siberia. An intensified fire regime might reshape future forest composition and increase the proportion of deciduous hardwoods compared to evergreen conifers with potential biophysical feedbacks to regional and global climate.

However, we currently lack understanding and quantitative studies on the mechanisms shaping post-fire regeneration patterns.

We measured site conditions and post-fire tree regeneration composition from five burned areas in Central Siberia, made dendrochronological observations, and inferred seed sources from high-resolution satellite data calibrated with ground data. We used boosted regression tree models to quantify the importance of site conditions (e.g. soil moisture, topography, organic layer depth) versus seed dispersal limitation in shaping regeneration following stand replacing fires.

We show that seed dispersal limitation of evergreen conifers was the main determinant of regeneration composition. Soil moisture and charcoal layer thickness were less important.

We estimated the contemporary spatial distribution of successional pathways in three of the burns, and analyzed changes thereof under scenarios of intensified fire regimes (increasing area burned and fire severity).

Under intensified fire regimes, places with severe dispersal limitation for evergreen conifers increase substantially, causing an increase of deciduous forests.

Here, decreased coniferous seed sources within the burned areas due to enhanced fire severity was more important than increased burned area sizes.

The expected fire-induced shift in the landscape-scale distribution of forest types may affect climate-land surface feedbacks via alterations of albedo, Bowen ratio, and carbon cycling.

P4 - Age structure of seedling banks of Norway spruce in the Bavarian Forest National Park

Annika Gonther[1], Sascha Liepelt[1], Lars Opgenoorth[1], Birgit Ziegenhagen[1], Katrin Heer[1]

[1]University of Marburg, Marburg, DE, annika_gonther@web.de

Seedling banks play an important role in forest tree species regeneration and thus in forest dynamics. Little is known about the structuring of seedling banks and thus about selection processes acting on them, e.g. whether seedling banks are dominated by offspring from mast years or whether climatic factors leave their foot print on the age structure. Therefore, the characterization of the age structure of seedling banks promises to shed light on important selection processes. However, former studies suggest that the exact determination of the age of conifer seedlings is not trivial: Whorl counts do not correspond well with year rings at ground level and additional tree rings might be located below the ground.

In this study, we aim to gain a better insight into the age structure of Norway spruce (*Picea abies*) seedlings at two intensive study sites in the Bavarian Forest National Park (BFNP). First, we aim to determine the correlation among different methods to determine the age of seedlings of Norway spruce. In a second step, this data will be used to characterize the age structure of the seedling banks. Therefore, we collected samples of spruce seedlings of different age classes at two sampling sites located at ~ 700 m and ~ 1.300 m a.s.l in the BFNP. We measured height, diameter and the number of bud scales for each seedling. Afterwards, the shoot-root collar was cut into thin horizontal cross sections. By counting the annual growth rings above and below ground in each section we determined the zone with the maximal number of year rings. The age structure of the seedlings was then be correlated with data of mast years and climatic variations. First results will be discussed during the conference.

P5 - Modeling effect of management strategies on beech forest tree growth in the Eifel region (Germany)

Jaegyun Byun[1], Vanessa Bursche[1], Jonas Hausen[1], Klara Krämer[1], Martina Roß-Nickoll[1], Richard Ottermanns[1]

[1]RWTH Aachen University, Aachen, DE, jaegyunb@gmail.com

Tree height (H) and diameter at breast height (DBH) are fundamental morphometric tree attributes, whereas the ratio of tree height to DBH (H/D value) reflects forest stand stability. In a field study nine sample plots in beech forests (*Fagus sylvatica*) were installed as size of 30m x 50m (0.15ha) and divided into three types based on management strategies in order to confirm management effects on tree growth. We statistically examined H/D value of individual trees in differently managed stands to test whether there is a significant difference between the management strategies concerning H/D value by using generalized linear models (GLM). Near-natural managed stands (characterized by single tree selection) significantly differed from conventionally managed (shelterwood cutting) and totally reserved stands (no utilization). Growth equations (growth models) were empirically developed to predict tree growth dynamics for the three management strategies from height-diameter relationships. The single tree-based stand simulator SILVA was used to predict future individual tree growth from actual tree composition within the management types. Seed dispersal process is integrated into SILVA simulation as submodel to include natural regeneration. Data of similar latitudes provided by the International Co-operative Program on Assessment and Monitoring of Air Pollution Effects on Forests (ICP forests) are used to compare simulated tree growth and validate the model in a broader context. Combination of SILVA program and regeneration process allows the estimation of long-term impacts of management on stand structure.

P6 - Contribution of "System protected Areas Tolima - Colombia“ to associated water resources

Juan Diego Rojas Ramirez[1,2], Cesar Freddy Suárez Pacheco[2]

[1]Universidad del Valle, Cali, CO, juandiegore25@gmail.com
[2]WWF (World Wildlife Fund for Nature), Cali, CO, juandiegore25@gmail.com

At present water supply is a key element for the management and delimitation of protected areas for conservation and sustainable use, especially in terms of shaping the territory. In order to identify the importance of water supply as a guarantor for future ecosystem services an ecological and hydrological analysis was performed in the departmental *System of Protected Areas and other conservation strategies* (SIDAP) Tolima, Colombia. The contribution of SIDAP Tolima to the provision of water for supplying watersheds of the main aqueducts of the population centers of the department of Tolima was estimated. Therefore, in this study the importance of internal and horizontal precipitation in the water supply of high mountain ecosystems was investigated.

The ecological functions of SIDAP Tolima were evaluated by different geospatial analysis types (supply forest carbon, ecosystem representation and conservation gaps). The Total Annual Water Balance for the department was analyzed by using the web application ***AguAAndes*** and the hydrologic modeling applied to areas of the tropical Andes was evaluated using ***Fiesta****(Fog Interception for the Enhancement of Streamflow in Tropical Areas*) (Mulligan & Burk, 2005).

The total annual water balance in the department of Tolima ranged between 4 - 1200 mm/year in the Magdalena Valley and between 3000 - 5000 mm/year for high mountain areas. This analysis allowed to assess the contribution of water of SIDAP Tolima, representing 17.5% of the total offer of 12 watersheds supplying water, where national parks provide 98% and the other figures of conservation 2%. In conclusion, this indicates a significant role of SIDAP Tolima as an adaptation strategy to climate change as well as changes in land use. This is due to its potential in the conservation of the hydrological cycle regulation service which is highly important for future generations in the department.

Keywords: protected areas, ecosystem services, horizontal precipitation

P7 - Structural diversity alters species diversity-productivity relationship in mixed and single species dominated forests

Somidh Saha[1], Georgios Skiadaresis[1]

[1]Chair of Silviculture, University of Freiburg, Freiburg i. Br., DE, somidh.saha@waldbau.uni-freiburg.de

Stand structural diversity was seldom used as a covariate in quantifying species diversity and productivity relationship in young temperate broadleaved forests. Mul-

tiple tree species of different successional status, diversity in tree interactions, variable stand density, and management intervention could create diverse stand structure in relatively young forests, which may modify diversity-productivity relationship. Interactions between these attributes could influence the richness of forest ground vegetation as well. We aimed to quantify how structural and compositional diversity, light, stand density influence forest productivity and richness of ground vegetation in young planted forests. 5 stand pairs of oak group and row planting (reforestations after storm damage, 14 to 22 years old) were selected in the German states of Baden-Württemberg and Hessen. Nine 100 m^2 blocks were randomly installed in each stand (i.e. 90 blocks in total). Inventory of all vascular plants were done and light was measured by hemispherical photography. Generalized linear models were used for analysis. Group planting stands had significantly higher floral richness and comparable biomass to row planting. We found structural and species diversity, light and stand density had high positive effects on productivity in groups. Whereas; in rows, species diversity had no effect on productivity but high positive effect of structural diversity was found on productivity. Structural diversity coupled with higher light availability increased ground vegetation richness both in group. In row planting structural diversity had a positive effect on ground vegetation richness even under low light availability. This study concludes that structural diversity plays a crucial role in maintaining higher level of stand productivity and ground vegetation richness in young planted forests. Diverse forests consist of trees from early to late successional species can accelerate the positive effects of structural diversity on stand productivity.

P8 - Analysis of plant community structure and traits in differently managed forests in the low mountain range region Eifel (Germany)

Vanessa Bursche[1], Klara Krämer[1], Doris Breuer[1], Richard Ottermanns[1], Martina Roß-Nickoll[1]

[1]Institute for Environmental Research, RWTH Aachen University, Aachen, DE, vanessa.bursche@bio5.rwth-aachen.de

Ground vegetation is an integral part of forest ecosystems. It plays a fundamental role in nutrient cycling and provides an important habitat for numerous other species. Herb layer species can affect forest productivity and regeneration dynamics due to root and light competition. Though they are known to be influenced by silviculture, the effect of forest management on plant community structure and functional composition of herb layer species is not completely understood.

To evaluate the impact of forest management on plant species composition and forest ecosystem functioning we analysed the vegetation of different forest management types in the Eifel region (Germany): (1) beech forests taken out of use, (2) beech forests managed according to the single-tree selection method, (3) beech forests with shelterwood cutting and (4) spruce as well as (5) douglas-fir forests set up in conventional plantation style.

The total number and composition of herb layer species varied to large extends between the different management types. Due to changes in the species composition, we found differences in the following plant functional traits: light requirements, life form, shoot form, ecological strategy types and urbanity.

The results show that management practices have a significant influence on plant community structure and their ecological traits, especially by producing large canopy gaps which increase the light incidence. Consequently it can be assumed that the management lastingly affects forest ecosystem structures and functions.

P9 - SilValuta - Quantifying the effects of sustainable forest management: a case study in the Eifel region

Klara Krämer[1], Vanessa Bursche[1], Jae-Gyun Byun[1], Richard Ottermanns[1], Martina Roß-Nickoll[1]

[1]Institute for Environmental Research (Biology V), RWTH Aachen University, Aachen, DE, klara.kraemer@rwth-aachen.de

European beech forest represents the potential natural vegetation of Germany. Due to intensive silviculture practices in the past centuries, less than 5% of the German land area is covered by beech forest nowadays. The remaining beech stands are almost exclusively managed, because silviculture is still an important industrial sector in Germany.

Besides the production of timber, forest ecosystems provide a number of fundamental ecosystem services and functions and are a crucial habitat for many organisms as well as refuge for endangered species. To conserve these important functions for future generations, sustainable forest management is essential. However, the effects of different silvicultural practices are in many cases still not well understood.

In this project, we evaluate the ecological consequences of different types of forest management applied in the Eifel region (Western Germany) in terms of ecosystem integrity. One part of the project is focused on management related differences in acute and long-term tree stress level and resulting consequences for stand productivity and stability. Therefore, tree vitality parameters are monitored at individual and stand level. In addition, the impact of the management type on structural and functional composition of the forest community is studied. Predators (ground beetles, spiders, and centipedes), herbivores (weevils), sapro-xylophages (weevils, millipedes and woodlice) and higher plants are used at microhabitat and stand scale as bioindicators of different trophic levels. Finally, we study management related differences in forest structure and dynamics at stand scale. The goal is to achieve in-depth knowledge about drivers and alterations of forest ecosystem integrity and to give recommendations for sustainable silviculture.

P10 - Tree species admixtures as a motive for ecosystem services

Alexandra Wehnert[1], Franka Huth[1], Sven Wagner[1]

[1]Institute of Silviculture and Forest Protection, Dresden University of Technology, Tharandt, DE, alexandra.wehnert@freenet.de

Recalling that cultivated Scots pine and Norway spruce forests were primarily established for wood production (provisioning services), it can be assumed that any broadleaved tree species admixtures or other structural elements within these forests would add value in relation to other categories of ecosystem services (ESS)–regulation, habitat and support, and human well-being. But adopting tree species admixtures as a motive improving ESS will require addressing issues of tree age, admixture intensity, spatial distribution and the effect of contact zones between tree species.

Therefore an analysis of field data and a literature review have shown that different categories of ESS require broadleaved tree species with different traits (e.g. single-tree vs. bigger aggregates) as an admixture species in coniferous forests.

Spatial distribution of litter can be parameterisedbased on different species-specific functions. Moreover it is possible to prove comparable trends for admixture-dependent distributions of pH-value and mineral soil humidity. To prove such trends in faunal distribution are more complicated. The admixture effects on carabid distribution have shown connections to specific broadleaf or conifer species within a given forest area. For ground flora, the contact zones between different tree species admixtures have influenced species-specific presence and distribution (flora and fauna). From these examples, we see that more detailed and quantifiable information about tree species admixtures separated into spatial and temporal dimensions is needed. From the observed effects, it is apparent that (i) these effects are spatially limited, and that (ii) they can be contradictory for different ESS. Consequently, to integrate or segregate ESS on small-scale forest areas, priorities for ESS must be defined. The effects of tree species admixtures are spatially limited, and it can be difficult to combine specific tree species over a longer period.

P11 - Forest proximity enhances avian pest suppression in cacao agroforestry landscapes

Bea Maas[1], Yann Clough[1,2], Teja Tscharntke[1]

[1]Agroecology, University of Göttingen, Göttingen, DE, beamaas@gmx.at
[2]Centre for Environmental and Climate Research, Faculty of Science, Lund University, Lund, SE

Birds play a key role in the suppression of arthropods, withparticular importance in tropical agroforestry where their services potentially enhance crop yields and reduce herbivore damage. Accordingly, avian ecosystem services contribute to concepts of biodiversity-friendly landscape management and human well-being. However, contrasting results on the importance of local and landscape factors for avian ecosystem services complicate the understanding of effective management approaches. It is poorly understood, how avian predation success is related to the diversity and composition of the bird community, as well as to local management and forest structures.

We quantified avian predation success on dominant cacao pests using experimental exposure of artificial caterpillars in 15 smallholder cacao agroforestry systems differing in local shade-tree management and distance to primary forest. Our results were related to the identity and diversity of insectivorous birds (assessed with point counts and mist netting) to identify key species and functional groups. While bird predation success was not related to local shade-tree management or overall bird species diversity, it increased with proximity of primary forest. Furthermore, we identified the abundant Indonesian endemic lemon-bellied white-eye *Zosterops chloris* as the main driver of predation success on artificial prey.

In a second study, we investigated the effects of the rapid conversion of the forest margin landscape on the local population of the endemic finch-billed myna *Scissirostrum dubium*. Like many other forest margin species, Finch-Billed Mynas strongly depend on large, remnant forest trees, which are used as foraging and nesting sites. A repeated monitoring of remnant forest trees (>80 cm dbh) showed a loss of 92% of nesting sites of the Finch-Billed Myna in only two years. These results provide an alarming example of the immediate consequences of remnant forest tree losses in tropical human–dominated landscapes for species depending on this habitat structure. The associated impacts on ecosystem services and human well-being are still poorly understood.

In summary, we demonstrate that forest proximity and the presence of remnant forest structures are highly important for associated biodiversity and avian ecosystem services. Although their management does not necessarily depend on the same factors and strategies, the conservation of forest structures will likely benefit human needs and biodiversity conservation alike.

END OF SESSION 25

Session 26 - Energiewende in Deutschland: Folgen für die Biodiversität
Short title: Energiewende und Biodiversität

CHAIRS: PROF. DR. RAINER WALDHARDT, DANIEL WIEGAND, DR. STEFAN HOTES

O1 - A GIS-supported multi-criteria energy system optimization approach with integrated sustainability assessment

Sebastian Rauner[1], Marcus Eichhorn[1]

[1]Helmholtz Centre for Environmental Research - UFZ, Leipzig, DE, sebastian.rauner@ufz.de

Energy system analysis and scenario development is a research field receiving a lot of attention in the research community. Many very comprehensive energy system models with different approaches where therefore developed to meet the challenges of an ever increasing complexity which comes with the shift of the political focus away from conventional to renewable based energy sources. However these models widely focus on the simulation or optimization of only a few key aspects, among them greenhouse gas emissions and overall cost. The resulting scenario is then allocated to the available region top-down, considering, if any, only a few constraining criteria. This approach neglects the often on regional level relevant trade-off between cost effectiveness and environmental impacts. This paper is therefore aiming to first elaborate on the critique of the current environmental impact consideration in energy system models. Then an analysis of the regional energy supply and demand of Germany highlights the structure of the energy system and its clusters of environmental impact. Finally first approaches how to include relevant impact factors in an optimization model are presented.

O2 - Alternative Energiepflanzen: Eine Chance zur Erhöhung der Biodiversität in der Agrarlandschaft?

Ralph Platen[1]

[1]Leibniz-Center of Agraraian Landscape Research (ZALF), Müncheberg, DE, platen@zalf.de

Im Rahmen des Forschungsverbundprojektes „Entwicklung und Vergleich von optimierten Anbausystemen für die landwirtschaftliche Produktion von Energiepflanzen unter den verschiedenen Standortbedingungen Deutschlands – Phase III (EVAIII)“ untersuchten wir an zwei Standorten im Nordosten Brandenburgs jeweils vier Energiepflanzenflächen, von denen jeweils drei zu den alternativen Energiepflanzen (durchwachsene Siphie, Szarvasigras, Wildblumenmischung) zählen, auf die Vegetationsstruktur sowie die Laufkäfer- und Spinnentierzönosen. Auf der vierten Fläche wurde jeweils die klassische Energiepflanze Mais angebaut, die als Kontrollfläche diente. Wir untersuchten die Auswirkung der Vegetationsstruktur in den Energiepflanzenbeständen auf die Biodiversität der bodenbewohnenden Laufkäfer- und Spinnentierzönosen. Die Artenzahlen und die Arten- und ökologische Diversität

der Laufkäfer und Spinnentiere waren auf den reich strukturierten alternativen Energiepflanzenflächen am höchsten, im Mais jeweils am niedrigsten. Die Vegetationsstrukturvariablen erklärten in beiden Tiergruppen > 50 % der Varianz in den Artdaten. Die Individuenanteile der ökologischen und funktionalen Gruppen zeigten signifikante Unterschiede sowohl zwischen den Untersuchungsflächen als auch zwischen den Standorten. Die Artenanzahlen und die Individuenzahlen einzelner ökologischer und funktionaler Gruppen sind teilweise hochsignifikant mit den Deckungsgraden der Vegetationsstrukturvariablen Kulturpflanze, Kraut-, Gras- und Streuschicht sowie dem Anteil unbewachsenen Bodens korreliert. Wir schließen aus unseren Ergebnissen, dass der Anbau alternativer Energiepflanzen im Vergleich zum Mais zur Erhöhung der Vegetationsstrukturvielfalt und damit zu einer Erhöhung der Biodiversität in der Agrarlandschaft führen kann.

O3 - Die Habitateignung von Kurzumtriebsplantagen (KUP) für Laufkäfer (Col: Carabidae) und Spinnentiere (Arachnida: Araneae; Opiliones)

Jessika Konrad[1]

[1]Leibniz-Center of Agraraian Landscape Research (ZALF), Müncheberg, DE, konrad@zalf.de

Kurzumtriebsplantagen (KUP) sind Kultivierungssysteme für die erneuerbare Energieproduktion, die aus schnellwachsenden Gehölzen, z.B Weiden oder Pappeln mit Umtriebsperioden zwischen 2 und 20 Jahren bestehen. Die Bedeutung von KUP für die Biodiversität und Habitateignung für wirbellose Tiere wird aktuell kontrovers diskutiert. Der reduzierte Dünge- und Pflanzenschutzmitteleinsatz sowie eine geringe Bodenbearbeitung werden jedoch als allgemein positiv für die Tierwelt betrachtet. Unsere Untersuchungen fanden von 2011-2013 im westhessischen Mittelgebirge statt. Auf einer 25 ha großen Fläche wurden im Mai 2008 von der Firma Viessmann auf ehemaligen Ackerflächen Pappelhybriden zur Energieproduktion gepflanzt. Die KUP werden parzellenhaft in Abständen von 3 - 4 Jahren im Rotationsprinzip geerntet. In den vier untersuchten KUP waren unterschiedliche Aufwuchsstadien vorhanden. Als Vergleichsflächen wurden in der Umgebung der KUP ein Acker, eine Brache, eine Mähwiese, ein Feldgehölz und ein Wald mit Bodenfallen beprobt. Ziel unserer Arbeit ist, die Auswirkungen der KUP auf die Artenvielfalt und ihre Habitateignung für Laufkäfer- und Spinnentierzönosen zu analysieren und die Dynamik in der quantitativen Zusammensetzung der Acker- und Waldarten während des Aufwuchses und nach der Gehölzernte zu beschreiben. Die Artenzahlen sowie die Arten- und ökologische Diversität der Laufkäfer und Spinnentiere lagen in der gesamten Untersuchungszeit in den KUP im oberen Bereich. Zwischen den vier KUP bestand in allen Untersuchungsjahren eine hohe faunistische Ähnlichkeit. In den Flächen, die während der Untersuchungszeit nicht geerntet wurden, nahm der Anteil der Waldarten kontinuierlich zu, während der Anteil der Acker- und Grünlandarten sank. Nach der Holzernte von zwei Flächen nahm dort der Anteil der Waldarten hochsignifikant ab, er stieg jedoch im folgenden Aufwuchsjahr erneut an und erreichte für beide Tiergruppen nahezu das Niveau des ersten Untersuchungsjahres. Die qualitative und quantitative Zusammensetzung der ökologischen und funktionalen Gruppen ist z.T. hochsignifikant mit der Ausprägung der Vegetationsstruktur korreliert. Wir schließen aus unseren Ergebnissen, dass sich die untersuchten KUP positiv auf die Biodiversität und die Förderung von Waldarten auswirkt.

O4 - Nachhaltiges Heckenmanagement dient der Natur und der Energiewende

Peter Momper[1], Rainer Waldhardt[2]

[1]Bioenergie-Region Mittelhessen, Giessen, DE, p.momper@die-ac.de
[2]Justus-Liebig-Universität Giessen, Giessen, DE

Hecken prägen das Landschaftsbild, schützen vor Erosion und sind Lebensraum für viele Pflanzen und Tiere. Damit die Hecken mit ihren Funktionen erhalten bleiben, müssen Hecken alle ca. 10 Jahre geschnitten werden. Aktuell werden viele Hecken lediglich zurückgeschnitten, um Wege freizuhalten. Gleichzeitig wird der Heckenschnitt meist keiner Nutzung zugeführt, sondern entweder vor Ort gehäckselt und in die Bestände ausgebracht oder an Sammelpunkten verbrannt.

Unter Berücksichtigung von Vorhaben wie dem Wallheckenprojekt im Kreis Steinfurt (NRW) führte die Bioenergie-Region Mittelhessen in den Jahren 2012 bis 2014 im hessischen Vogelsbergkreis und im Landkreis Marburg-Biedenkopf mit Partnern der Universitäten Frankfurt, Marburg und Gießen, der Kreisverwaltungen, regionaler Betriebe zur Herstellung von Holzhackschnitzeln sowie weiterer Akteure der Energiewende Pilotprojekte mit dem Ziel der Etablierung eines nachhaltigen Heckenmanagements durch: Dieses soll einerseits eine fachgerechte Pflege von Hecken sicherstellen und andererseits durch energetische Nutzung (u.a. durch regionale Bioenergiedörfer) des Heckenschnitts einen Beitrag zur Energiewende leisten.

Die Pilotprojekte erbrachten u.a. folgende Ergebnisse: Unter bestimmten Voraussetzungen können durch den Verkauf den Holzhackschnitzeln aus Heckenmaterial die Kosten für den fachgerechten Heckenschnitt gedeckt werden. Allerdings ist die Streuung der Erträge und Kosten erheblich. Im Vogelsbergkreis ergab sich ein Holzhackschnitzelertrag von durchschnittlich 35 Schüttraummetern pro 100 Meter Heckenabschnitt. Weitere Einflussfaktoren auf die Ertrags- und Kostenstruktur sind die Zusammenstellung der Lose, die Befahrbarkeit der Wege, der Feuchtgehalt der Hackschnitzel, die Vermarktungsart (Stichwort Direktvermarktung) sowie die mehr oder weniger große Akzeptanz eines derartigen Heckenmanagements durch Kommunen, Bewirtschafter angrenzender Landwirtschaftsflächen und die ländliche Bevölkerung allgemein.

END OF SESSION 26

Session 30 - Approaches and methods to quantify ecosystem services
Short title: Ecosystem services, methods, quantification

CHAIRS: PHILIPPE JEANNERET, MATTHIAS ALBRECHT

O1 - Wild Food, Water and Carbon: aiming for consistency in an ecosystem service methodology

Katherine Horgan[1]

[1]University of Zürich, Zürich, CH, katherine.horgan@ieu.uzh.ch

While classification systems, such as CICES (Common International Classification of Ecosystem Services) and the work of the MEA have largely established a systematic approach towards classifying ecosystem services, standardised methodologies have been slower to emerge from the research field. This is in part due to multiple methods being developed and because the ecosystem services approach is applied to answer a diverse range of questions.

Two approaches, InVEST and TESSA, are designed to assess ecosystem service provision, to quantify those services and to develop possible future scenarios under certain conditions. Within the scope of a PhD project that will provide an overview of ecosystem services at a suite of 6 at globally distinct sites, we aim to test consistency in the use of one methodology.

We have established a baseline measure of all potential site services and are now using TESSA's approach to collect more detailed data for 3 ecosystem services common to all research sites – carbon storage, wild food gathering and drinking water provision. We hope for twofold results: to have a good picture of ecosystem service provision across the research sites and to understand the strengths and limitations of standardising our approach across ecosystems.

O2 - A Rapid Ecosystem Function Assessment (REFA) to quantify ecosystem service provisioning

Sebastian T. Meyer[1], Wolfgang W. Weisser[1]

[1]Technische Universität München, Freising-Weihenstephan, DE, sebastian.t.meryer@tum.de

Quantifying ecosystem functioning is important for both basic and applied research in ecology. However, there is a lack of standardized and easy-to use methods to quantify ecosystem functions and services. Consequently, there is a gap between the data available and the data needed to answer topical questions in ecology. We identify a set of functions including productivity and soil conditions, the saprophagic break-down of organic material and consumer-plant interactions as a basic descriptor of overall ecosystem functioning. We aim at proposing REFA methods to measure proxies for these functions based on a literature review. Proposed methods were specifically selected to be low-tech, easy to use, repeatable, and cost-efficient. Thus, they enable standardized and comparable measures of functions on large scales.

The identified methods are introduced. For example, Primary productivity can be approximated by standing plant biomass. Decomposition is approximated by the weight loss of a standardized substrate. Invertebrate herbivory can be measured scoring leaves for damage. Predation can be quantified as the attack rate on exposed artificial caterpillars made from placticine, pollination as the number of insects attracted to pan traps, and seed dispersal as the removal of a standardized grains. Case studies using REFA along an experimental plant-diversity gradient and in an applied land-use context are presented. We show that REFA methods were able to reproduce the relationships between functions, diversity and land-use that have been documented using more detailed and labor-intensive methods. Therefore, we conclude that there is not only a need for more comparable data on ecosystem functioning but also a great potential for employing REFA-methods that quantify proxies suitable to answer critical questions about drivers of functioning in different ecosystems under global change and the best management to sustain provision of ecosystem functions and services.

O3 - Quantifying predation in terrestrial ecosystems

Klaus Birkhofer[1]

[1]Lund University, Lund, SE, Klaus.Birkhofer@biol.lu.se

Predation as a biological interaction during which a predator feeds on prey shapes natural and anthropogenic terrestrial ecosystems. Fundamental concepts and sub-disciplines in ecology are centred on such trophic interactions, e.g. keystone predation, biological control or trophic cascades. Predation provides crucial ecosystem services to human societies, as predators for example reduce or control the damage caused by forest or agricultural pests, supress vectors of human diseases and may conserve pristine conditions in natural ecosystems. The past and ongoing interest in predation research has yielded an impressive number of methods to assess predation in terrestrial habitats. The majority of existing methods used to address predation can be grouped into the following categories: observations, cage experiments, bait/sentinel prey and molecular, stable isotope or fatty acid analyses. Until now, no single, up-to-date review covers all these approaches in a comprehensive way. Illustrating the advantages and disadvantages of these methods in terms of their suitability for different ecosystems/habitats, types of questions and budget constraints will improve future assessments of the contribution of predators to the provision of ecosystem services. Exemplifying their application based on published case studies will further contribute to a better knowledge base from which future studies on predation-related ecosystem services could greatly benefit.

O4 - On the use of sentinel preys to estimate pest control potential

Philippe Jeanneret[1], Louis Sutter[1], Amélie Mandel[1], Matthias Albrecht[1]

[1]Agroscope ISS, Zurich, CH, philippe.jeanneret@agroscope.admin.ch

Biocontrol of pests by predators in agricultural fields is an important ecosystem service that can improve agricultural production and decrease the use of detrimental pesticides. The estimation of the predation of pests, in particular arthropods, in crop fields maybe approached by the use of generic sentinel preys with the considerable advantages of possible standardization to any kind of crops. So, the measure of predation potential can easily be compared across crop types, countries, etc., and be confronted to ecological factors of influence such as the proportion of semi-natural habitat in the landscape. We will show the method of generic sentinel preys which was used during the EU FP7 project QuESSA in eight case studies across Europe. Two kinds of sentinels were used, i.e. larvae of the bluebottle fly (*Calliphora vomitoria* L., Diptera) and eggs of the mill moth (*Ephestia kuehniella* (Zeller), Lepidoptera). Predation on sentinels was measured following a standardized design, i.e. in 18 fields in each case study at 4 distances from the border to the center, in variable situations of field margins, i.e. either grassy or woody elements or another crop (6 fields of each), and in a gradient of semi-natural habitat proportion in a 1km radius sector around the fields. In addition to the predation of sentinel preys, each case study has also measured the predation rate of one of the most important pests of the crop (for instance the pollen beetle in oilseed rape fields). Usefulness of the sentinel methods will be discussed in the context of sensitivity to explanatory variables, the correlation with the predation rate of the pests, and the practicability.

O5 - Synergistic interactions of ecosystem services: pests control boosts yield increase through insect pollination in oilseed rape

Louis Sutter[1,2], Matthias Albrecht[1]

[1]Agroscope, Institute for Sustainability Sciences ISS, Zurich, CH, louis.sutter@agroscope.admin.ch
[2]University of Zurich, Institute of Evolutionary Biology and Environmental Studies, Zurich, CH, louis.sutter@agroscope.admin.ch

Insect pollination and pest control are key ecosystem services (ES) in sustaining global food production. However they have mostly been studied in isolation and how they interactively shape crop yield, and the mechanisms driving such interactive effects, remain largely unexplored. We experimentally examined the interactive effects of insect pollination (hereafter pollination) and simulated pest control on oil-seed rape (OSR) yield and tested a series of hypothesized underlying mechanisms. We found a strong synergistic effect of pollination and pest control on OSR yield quantity (total number and weight of seeds per ha) and quality (oil content).

The combined effects of pollination and pest control increased OSR yield by 23%, while their single contributions were 7% and 6% respectively.The economic benefit for a farmer from synergistic pollination-pest control effects on yield quantity and quality amounts to 429 €/ha, more than three times that from the individual contributions of pollination (118€/ha) or pest control (110€/ha). Our results indicate that the principal mechanism behind this pronounced positive interaction is an average reduction in flower life-time of 60% at high pollen beetle densities, which, through feeding on pollen induce flower withering in OSR. As a consequence, the average number of visits a flower receives during its life-time drops from 2.5 to 1.2 visits under natural pollinator visitation rates. Our findings highlight the importance of considering interactions among multiple ES, such as pollination and pest control, with profound implications for management and policy. Such interactions need to be taken into account in ES models; to correctly estimate predictions for effective ES management.

O6 - Flower based ecosystem service potential of surrogate grassland habitats, considering phenological dynamics and user group specificity

Laura Kütt[1], Jaan Liira[1]

[1]University of Tartu, Tartu, EE, a61667@ut.ee

Do grassland's surrogates, such as grassy field margins and road verges, offer ecosystem services with the same quality as permanent semi-natural grasslands? We estimated the floral service potential of habitats on the basis of flower colour and from the perspective of two ecosystem service user groups, humans and pollinators. Trait's service providing functionality was evaluated via three properties: functional diversity, intensity and intrinsic diversity as stability. Indicators of these properties were respectively colour richness, flower unit size, and within colour richness. We studied three surrogate habitat types, two successional age groups of field margins (1st and 3rd year) and road verges, and permanent grasslands in agricultural landscape.

All three service provision properties of the trait had the greatest value in permanent grasslands, indicating the lower service quality potential of surrogate habitats. Among surrogate habitats, the 1st year field margins had greater colour richness, and species richness within colour groups, but the smallest average flower unit size. All three properties contrasted to road verges, but these properties became more similar to road verges already in the third year of field margin's succession. Across habitats, floral properties were similar from pollinator and human perspective.

None of the surrogate habitats support the stable service delivery as permanent grasslands do. Even if young field margins appear to support some flower based services a bit more than road verges, they do it only shortly, during a few years of succession. In long run, field margins loose service quality provided by weed species, and start to resemble road verges. We conclude that permanent grasslands in agricultural landscape cannot be substituted by alternative linear habitats and, therefore, remnant fragments of semi-natural grassland should receive the first priority attention of conservation and restoration. The service quality for both user groups can be monitored using only a single service user group.

O7 - Modelling the impact of changing environmental conditions on ecosystem service provision under different climate and land use scenarios

Anett Schibalski[1], Katrin Körner[2], Florian Jeltsch[2,3], Boris Schröder-Esselbach[3,4]

[1]Institute of Earth and Environmental Science, University of Potsdam, Potsdam, DE, anett.schibalski@uni-potsdam.de
[2]Plant Ecology and Nature Conservation, University of Potsdam, Potsdam, DE
[3]Berlin-Brandenburg Institute of Advanced Biodiversity Research BBIB, Berlin, DE
[4]Institute of Geoecology, Technical University of Braunschweig, Braunschweig, DE

The collaborative research project COMTESS (Sustainable coastal land management: Trade-offs in ecosystem services) investigates the impact of climate change, sea level rise and different management options on ecosystem service (ESS) provision by coastal vegetation at the German North and Baltic sea coast. A chain of hydrological, ecological and socio-economic models predicts the impact of changing climatic and sea level conditions on the hydrology, the composition of plant communities and finally ecosystem service provision of the study regions. We consider services as vegetation-mediated (e.g. forage production) or directly depending on hydrology (e.g. reduced flood risk due to retention of excess water in polders or the reduction of global warming potential, which is directly related to groundwater levels and conductivity). Vegetation-mediated services, on the other hand, are modelled depending on the distribution of single plant species (species distribution models which in turn depend on the varying hydrology of the study region). Plant traits, i.e. the community-weighted mean (CWM) of the resulting species composition on a site, are then related to ecosystem services (e.g. fodder marginal income is related to the CWM of species-specific grassland utilization indicator values). We have developed a tool for synthesis and visualisation in order to incorporate all steps of that modelling chain. Our setup of temporally and spatially explicit modelling and static ecosystem property-to-ecosystem service-relationships can be easily adapted as a general framework for similar tasks in other regions or including different ecosystem services. Parts of the modelling shell can be easily adjusted, replaced or simplified according to available data.

O8 - The effects of diversity on growth: From synthetic tree communities to national forest inventories

Stephan Kambach[3,6], Eric Allan[2], Simon Bilodeau-Gauthier[4], Helge Bruelheide[4,6], Josephine Haase[9], Tommaso Jucker[7], Georges Kunstler[14], Sandra Müller[9], Alain Paquette[18], Sophia Ratcliffe[20], Fabian Roger[21], Paloma Ruiz-Benito[22], Harald Auge[3,4], Olivier Bouriaud[5], Bastien Castagneyrol[10,11], David Coomes[7], Jonas Dahlgren[8], Lars Gamfeldt[21], Hervé Jactel[10], Julia Koricheva[13], Gerald Kändler[12], Aleksi Lehtonen[16], Bart Muys[17], Quentin Ponette[19], Michael Scherer-Lorenzen[9], Nuri Setiawan[23], Thomas Van de Peer[17], Kris Verheyen[23], Christian Wirth[4,20], Miguel A. Zavala[24], Charles Nock[9]

[2]Institute of Plant Sciences, University of Bern, Bern, CH
[3]Department of Community Ecology, Helmholtz-Centre for Environmental Research - UFZ, Halle, DE
[4]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE
[5]Forest Research and Management Institute, Bucharest, RO
[6]Institute of Biology/Geobotany and Botanical Garden, Martin-Luther-University Halle-Wittenberg, Halle, DE
[7]Forest Ecology and Conservation Group, University of Cambridge, Cambridge, UK
[8]Department of Forest Resource Management, Swedish University of Agricultural Sciences, Umeå, SE
[9]Faculty of Biology - Geobotany, University of Freiburg, Freiburg, DE
[10]INRA, UMR1202 BIOGECO, Cestas, FR
[11]Univ. Bordeaux, UMR1202 BIOGECO, Talence, FR
[12]Department of Biometrics and Informatics, Forest Research Institute of Baden-Wuerttemberg, Freiburg, DE
[13]School of Biological Sciences, Royal Holloway University of London, Egham, Surrey, UK
[14]Irstea, UR EMGR, Centre de Grenoble, Saint-Martin-d'Hères, FR
[15]Department of Biological Sciences, Macquarie University, Sydney, AU
[16]Natural Resources Institute Finland, Vantaa, FI
[17]Department of Earth and Environmental Sciences, KU Leuven (University of Leuven), Leuven, BE
[18]Centre for Forest Research, Université du Québec à Montréal, Montréal, CA
[19]Forest science laboratory, Catholic University of Louvain, Louvain la Neuve, BE
[20]Institute of Special Botany and Functional Biodiversity Research, University of Leipzig, Leipzig, DE
[21]Department of Biological & Environmental Sciences, University of Gothenburg, Gothenburg, SE
[22]Biological and Environmental Sciences, School of Natural Sciences, University of Stirling, Stirling, UK
[23]Forest & Nature Lab, Ghent University, Gontrode-Melle, BE
[24]Forest Ecology and Restoration Group, Department of Life Sciences, Universidad de Alcalá, Alcalá de Henares (Madrid), ES

The relationship between tree diversity and productivity has been of interest for a long time and has been investigated with experiments and observations. To assess the functional significance of forest biodiversity in Europe the FunDivEUROPE project compiled data from three distinct approaches: the experimental platform (six tree diversity experiments), the exploratory platform (comparative plots established in six mature forests, selected for homogeneity in tree species proportions and abiotic conditions) and the inventory platform (a dataset of seven harmonized national forest inventories). We averaged yearly stem size increments at the species level on each plot and compared species' growth between monocultures and two-, three- or four-species mixtures, adding up to 497, 77 and 626 observations in the experimental, exploratory and inventory platform.

Since the diversity experiments are relatively young and cover only a narrow range of environmental conditions, species interactions might not be as pronounced as in mature forests of which forest inventories can cover a large gradient in species composition, forest age and environmental conditions. We thus asked if the experimental approaches yield weaker relationships between tree diversity and size increments than the exploratory and especially inventory approach. Furthermore, we tested how much of the variation in productivity could be attributed to differences in tree species composition.

Our results indicated non-significant relationships between tree diversity and productivity in all three platforms. Species composition explained only small amount of variation in productivity and was significant only in forest inventories.

We concluded that, at the plot level, there is no general relationship between tree species richness and productivity. Documented interaction effects might apply only for specific target species in mixture with a particular set of tree species and under restricted abiotic conditions.

O9 - Contrasting demands on urban green providing cultural ecosystem service in Berlin

Maraja Riechers[1,2], Teja Tscharntke[1], Jan Barkmann[2]

[1]Agroecology, Department of Crop Science, Georg-August-Universität Göttingen, Göttingen, DE
[2]Environmental and Resource Economics, Department of Agricultural Economics and Rural Development, Georg-August Universität Göttingen, Göttingen, DE, mrieche@gwdg.de

Urban ecosystems improve biodiversity, mitigate urban heat effects and contribute to public health. However, protection of urban ecosystems is difficult, as competition for economical usage of this land is high. Commercial use, residential development and the increasing use for recreational purposes require a balanced, comprehensive planning along with careful management of green spaces. Cultural ecosystem services can be one way to gain information on these conflicting aspects. However, urban landscapes or green spaces have been neglected in the cultural ecosystem services research so far and are only slowly becoming of more interest. Additionally, CES categories are described as difficult to value and quantify due to their heterogeneous and subjective character.

In this presentation we will present social factors influencing cultural ecosystem services importance in urban areas using social research methods. Based on qualitative semi-structured interviews (*n* = 41), we conducted a quantitative, non-monetary survey of cultural ecosystem services provided by urban green in Berlin. We used a representative face-to-face survey, using on proportioned stratified sampling. Data (*n* = 558) were collected in two sampling rounds in four districts of Berlin. We found a high appreciation of cultural ecosystem services for all 10 variables which we assessed. Our study showed a dichotomy regarding factors such as age and urban–peri-urban gradient, defined through population density. On the one hand, results show social group consisting of younger urban dwellers which value cultural ecosystem services rather homogeneously, but slightly prefer services which promote social interactions, such as values for social relations and cultural diversity. Additionally, they visit parks and open green spaces the most. On the other hand, we find older inhabitants, living in more peri-urban areas which prefer cultural ecosystem services related to direct natural experiences, such as values for education, religious and spiritual values.This group shows a significant distinction between their preferences, as services concerning human interactions are valued much less. This dichotomy indicates possible conflicting preferences and has value for green space management and urban planning. We perceive cultural ecosystem services as an interesting link between the social andecological dimensions, showing interactions often overlooked in research and policy making.

O10 - A review of urban ecosystem services: six key challenges for future research

Anna-Lena Rau[1]

[1]Leuphana University of Lüneburg, Lüneburg, DE, anna-lena.rau@leuphana.de

Global urbanization creates opportunities and challenges for human well-being and transition towards sustainability. Urban areas are human-environment systems that depend fundamentally on ecosystems, and thus require an understanding of the management of urban ecosystem services to ensure sustainable urban planning. The purpose of this study is to provide a systematic review of urban ecosystems services research, which addresses the combined domain of ecosystem services and urban development. We examined emerging trends and gaps in how urban ecosystem services are conceptualized in peer-reviewed case study literature, including the geographical distribution of research, the development and use of the urban ecosystem services concept, and the involvement of stakeholders. We highlight six challenges aimed at strengthening the concept's potential to facilitate meaningful inter- and transdisciplinary work for ecosystem services research and planning.

Achieving a cohesive conceptual approach in the research field will address (i) the need for more extensive spatial and contextual coverage, (ii) continual clarification of definitions, (iii) recognition of limited data transferability, (iv) more comprehensive stakeholder involvement, (v) more integrated research efforts, and (vi) translation of scientific findings into actionable knowledge, feeding information back into planning and management. We conclude with recommendations for conducting further research while incorporating these challenges.

P1 - Application of a Spatial Land-Use Model to Assess Opportunities and Problems for the REDD+ mechanism and competing land-use objectives

Rebekka Hüfner[1]

[1]Rebekka Hüfner, Kassel, DE, rebekka.huefner@usf.uni-kassel.de

Human activities have altered the global carbon cycle profoundly and non-reversibly. The necessity to avoid or at least lessen the negative effects of the ensuing environmental and climate change through mechanisms of adaption and mitigation has been acknowledged by international and national organizations and governments and by researchers of various disciplines. Since deforestation and degradation of tropical forests contribute about 10% to 15% of GHG emissions, there is a huge potential for mitigation through carbon sequestration in the tropical forests. Therefore the REDD mechanisms were created to support afforestation, reforestation, forest conservation and simultaneously an improved forest management to mitigate GHG emissions. Apart from being sinks for carbon there are additional reasons to protect forests from conversion to other land use types: They play important roles in climatic processes on different scales, they are a habitat to many animals and plants, thus taking an important role in biodiversity conservation, they prevent soil degradation, decrease flood and landslide risks, improve water availability and quality, in many places they have important recreational and cultural functions and they provide livelihoods and food in often poor rural regions. All this desired ecosystem services depend on the health and often on the spatial context of the forests. Due to that it is not only important how much forest is saved or restored, but also where these areas are located. Sometimes it might be possible to realize several benefits in one area. But since land is a limited resource competition is inevitable. To gain insights into possible future land uses and land-use changes the global land-use model LandSHIFT was developed. LandSHIFT is a dynamic, integrated model that uses bottom-up and top-down mechanisms to simulate land-use change on the global and regional scale. My poster presentation will give an overview on how the model will be improved (e.g. by adapting the methods for suitability analysis and by adding an improved forest production module) to investigate the following research questions: Where are areas with a high risk for competition between REDD and other important services like food production, bioenergy production and biodiversity? Will these competitions promote leakage or indirect land use change? And how can competitions be avoided or minimized?

P2 - Ecosystem services assessment in the Darß Zingst Bodden Chain, Northern Germany

Marion Kruse[1,2], Maike Piepho[1]

[1]University of Rostock, Rostock, DE
[2]Christian-Albrechts-University Kiel, Kiel, DE

Ecosystem services are the contributions to human well-being by ecosystems. These ecosystem services and benefits are manifold and underlie temporal and spatial changes. Knowledge on changes in ecosystems and ecosystem services are important for a sustainable land use management. In recent years, significant steps have been undertaken for a better understanding of ecosystem services and the application of the concept into decision-making and policy-making. However, mostly information arises from terrestrial case studies. Linking of aquatic and terrestrial ecosystem services is an important aspect in coastal areas as many ecosystem services interact with each other. Therefore, the concept of ecosystem services is as an essential aspect in the project BACOSA (Baltic Coastal System Analysis and Status Evaluation) with its case study area the Darß Zingst Bodden Chain in Northern Germany. The Darß Zingst Bodden Chain, which is a shallow lagoon at the southern Baltic Sea, comprises of specific features, such as unique terrestrial and aquatic ecosystems. Today, the case study area has a prominent position for recreational activities and tourism, especially in relation to nature and coastal dynamics and it is partially protected as part of the National Park Vorpommersche Boddenlandschaft. Due to agricultural activities in the catchment area, there is high nutrient input into the Bodden, which has effects on the aquatic communities (e.g., macrophytes). Special attention within the project is turned to the contributions of macrophytes and reed, which are subject to changes in spatial extent within the past decades.

Qualitative, quantitative and economic assessment methods are combined to evaluate the ecosystem services supplied in the Darß Zingst Bodden Chain. Macrophytes and reed contribute especially to regulating ecosystem services, such as nutrient regulation. Negative interactions are partially given in regard to touristic and recreational activities. A comparison of several data sets gives information on the changes in the aquatic communities (1970s to today). The consequences for ecosystem service supply is discussed. The gained knowledge gives valuable contributions for environmental management in coastal areas.

END OF SESSION 30

Session 31 - Assessing ecosystems –from ecological knowledge to informing policy

Short title: Assessing ecosystems

CHAIRS: STEFAN HOTES, ALETTA BONN, MALTE TIMPTE

O1 - IPBES - How to get involved

Mariam Akhtar-Schuster[1], Uta von Witsch[1]

[1]PT-DLR German IPBES Coordination Office, Bonn, DE, Uta.von-Witsch@dlr.de

The *intergovernmental science-policy platform on biodiversity and ecosystem services* (IPBES) will respond to requests for scientifically proven information on biodiversity and ecosystem services coming from Governments, Multilateral Environmental Agreements and other stakeholders, hereby providing a necessary basis for a sustainable management of biodiversity and ecosystem services.

IPBES provides a unique opportunity for:

a) Identifying existing and credible scientific information needed by policymakers;

b) Performing assessments of knowledge on biodiversity and ecosystem services;

c) Supporting policy formulation and implementation by identifying policy-relevant tools and methodologies;

d) Prioritizing key capacity-building requirements needed to strengthen the implementation of its activities.

To ensure its effectiveness, IPBES will collaborate with existing initiatives, and provide unbiased scientific information that has been collected, validated and synthesized through transparent, independent and peer-reviewed processes.

The Federal Ministries for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and of Education and Research (BMBF) have established the German IPBES Coordination Office to e.g. identify national experts and capacities that can support the IPBES activities, and to assist experts in getting involved in IPBES in order to ensure that their knowledge will be included in the process and effectively communicated.

A series of regional assessments as well as a scoping for a global assessment will be started in 2015. This presentation will outline the IPBES process, the role of the German IPBES coordination office, and describe how experts can get involved.

O2 - IPBES pollination assessment - experiences of the first year and comparisons to IPCC

Josef Settele[1]

[1]UFZ, Halle, DE, Josef.Settele@ufz.de

Experiences from the first year of the IPBES pollination assessment will be presented. There the author acts as CLA (Coordinating Lead Author) of the "Drivers" chapter. Based on his previous role as CLA in the 5th Assessment Report of the IPCC he will make some comparisons between the IPCC and IPBES procedures.

O3 - Assessing limitations in global biodiversity information

Carsten Meyer[1], Susanne Fritz[2], Robert P. Guralnick[3], Walter Jetz[4], Holger Kreft[1], Patrick Weigelt[1]

[1]Georg-August-Universität, Göttingen, DE, cmeyer2@uni-goettingen.de
[2]Biodiversity & Climate Research Centre (BiK-F) & Senckenberg Gesellschaft für Naturforschung, Frankfurt am Main, DE
[3]University of Florida, Gainesville, US
[4]Yale University, New Haven, US

The countries have agreed to improve and share biodiversity knowledge by 2020. Hence, a key activity of the IPBES assessment process is the analysis of gaps, biases and uncertainties in relevant information, such that these limitations can be overcome effectively. Focusing on species distributions, a vital component of biodiversity knowledge, we analyzed global patterns and drivers of limitations in biodiversity information, by integrating 0.3 billion occurrence records for vertebrates and plants with independent expert knowledge. We find that outside a few well-sampled regions such as Western Europe, distribution information is coarse, incomplete, and rife with taxonomic, spatial and temporal biases and uncertainties. Surprisingly, large emerging economies are particularly underrepresented in globally mobilized information, even more so than species-rich, developing countries in the tropics. We found very high levels of information duplication, highlighting inefficiencies in the mobilization and dissemination of distribution information. Currently-used knowledge indicators are unsuited to monitor the various, largely uncorrelated limitations in information. Using multi-model inference, we identified the key factors limiting distribution information across different taxa, spatial grains and extents. At the level of grid cells, information is mainly limited by distance to researchers, national research funding, and political cooperation with data-sharing networks. These socio-economic factors also limit information at the species level, which is additionally constrained by range size and shape, whereas species attributes related to detectability or sampling logistics (e.g. body size) have surprisingly low effects. Our results highlight the need for an intensified cooperation and targeted integration of non-Western data sources, to more effectively address biodiversity knowledge needs.

O4 - Review of (sub-)national ecosystem assessments: objectives, concepts, methods, and governance

Aletta Bonn[1,2,] Matthias Schröter[1,2], Christian Albert[1], Claire Brown[3], Stefan Klotz[1], Sandra Lavorel[4], Joachim Maes[5], Alexandra Marques[2], Wolke Tobon[1,2],

[1]Helmholtz Centre for Environmental Research - UFZ, Leipzig, DE, aletta.bonn@idiv.de
[2]German Centre for Integrative Biodiversity Research (idiv) Halle-Leipzig-Jena, Leipzig, DE, matthias.schroeter@idiv.de
[3]UNEP-WCMC, Cambridge, UK
[4]Laboratoire d'Ecologie Alpine, Grenoble, FR
[5]Joint Research Centre, Ispra, IT

Interest in monitoring ecosystems and the services they provide has increased in policy-making over the last decades. The EU Biodiversity Strategy aims for maintaining and enhancing ecosystems and the services they provide by 2020. To fulfil this target, the strategy calls upon member states to "map and assess the state of ecosystems and their services in their national territory". Only few countries, however, have completed such ecosystem assessments so far. In this study, we review published (sub-)national ecosystem assessments from Portugal, Spain, United Kingdom, Flanders (Belgium), Norway and Finland, as well as scoping studies from Germany, the Netherlands and Switzerland. We review their aims and objectives, their relation to policy questions, their conceptual frameworks, ways to incorporate biodiversity information in the assessments, assessment methods as well as the governance and policy mandates of the assessments. Concerning the content of the assessments, we were particularly interested in whether they addressed recurring questions and current challenges concerning mapping and assessing ecosystem services (distinction of different components of services, uncertainties, dependence of a country on ecosystem services produced outside the country).

We observed an evolution of assessments. Early assessments (e.g., Portugal, Spain, UK) resembled the Millennium Ecosystem Assessment and were largely on descriptive literature research and expert judgments on condition, trends and scenarios for ecosystem services. Later assessments (e.g. Flanders) were conceptualized and elaborated as spatially explicit biophysical assessments that contained different aspects of valuation of services. The inclusion of biodiversity and its role in the provision of services was largely qualitative based on expert judgements. All assessments report large knowledge gaps on the complex role of biodiversity for the provision of services.

O5 - Assessing Land Use Change and its Effect on Ecosystems and Peoples' Well-being in Tinoc, Ifugao, North Philippines

Florence Daguitan

Submission by Tebtebba, Indigenous People's International Centre for Policy Research and Education in Partnership with the Naundep ni Napaknuhan ni Kalanguya

An ecosystem assessment was conducted in Tinoc, Ifugao by looking into the status and trends of (1) land use and land use change, (2) land tenure, (3) traditional knowledge, (4) traditional occupation and (5) well-being using the participatory action research. Data generation included key informants interviews, group discussions, surveys, mapping and resource inventory. The process of analyzing changes included the documentation of their indigenous knowledge systems and practices (IKSP) in territory management which was the norm before the invasion of chemical based, commercial vegetable farming. The people were able to discern the wisdom and science of their IKSP that features sustainable resource use that is underpinned by biodiversity, culture and spirituality. Also equitable sharing of resources was very much evident, hence the conclusion that indigenous territory management systems of the Kalanguya conforms with the ecosystems-based approach of the UN Convention on Biological Diversity. This was shared to other IP organizations in nine countries who found most of the features of the Kalanguyas' territory management as similar to what they have.

Looking at the present situation, communities were able to arrive at a common view that veering away from their traditional knowledge and adopting the chemical-based commercial monocrop vegetable production have caused deforestation and consequent decrease of water from natural springs and impacted negatively on water quality, food security and health of the children. From these findings, a comprehensive land use plan anchored on their IKSP was formulated for sustainable development. To date, the different communities have formed their alliance and adopted a holistic approach to development that will address issues of biodiversity, climate change and poverty.

O6 - Assessing ecosystems for policy support in a disaster zone: distribution of amphibian and insect species in Moune District, Kesennuma City after the 2011 Tsunami disaster

Tomohiro ICHINOSE[1], Satoru ITAGAWA[2]

1: Faculty of Environment and Information Studies, Keio University

Endo 5322, Fujisawa, Kanagawa, 252-0882 Japan, tomohiro@sfc.keio.ac.jp

2: Graduate School of Media and Governance, Keio University

A magnitude 9.0 earthquake struck the Pacific Ocean off northeastern Japan on 11 March 2011. The subsequent tsunami wrought destruction on a massive scale.

Kesennuma City was one of the most heavily damaged regions in Miyagi Prefecture, where more than thousand people were killed by the tsunami and subsequent fires, and 230 people are still missing. In response to the disaster, Miyagi Prefecture has been presented with plans for breakwaters ranging from 5.0 to 11.8 meters (m) in height, even though the most recent tsunami topped 12 m. Most breakwaters, with a total length of 25 kilometers, have already been constructed along the Sendai Costal Area. However, one fishing village in Kesennuma, called Moune, has submitted a formal request to the mayor of Kesennuma to withdraw the plan for its 10-m breakwater, because most households will relocate to a new residential area outside the area at risk of tsunami impact. The district is already famous for its afforestation movement, called Mori wa Umi no Koibito ("The Forest is a Lover of the Sea"). In 1989, an oyster farmer named Shigeatsu Hatakeyama started planting trees on the hills around the village to preserve the seawater quality for his oysters. His activities have influenced previously-uninterested residents to object to the breakwater plan.

To provide ecological information that may be relevant for developing policies for sustainable reconstruction of areas affected by the tsunami disaster, the distribution of organisms and environmental changes in the disaster area of Moune after the 2011 tsunami have been investigated. We have recorded the number and location of egg masses of the Tohoku salamander Hynobius lichenatus, which is an endangered species, and the distribution of aquatic insects. We counted 680, 445, 261 and 481 egg masses in 2012, 2013, 2014 and 2015, respectively. In the first spring after the tsunami we found the huge number of egg masses in the wetlands created by the tsunami, however most egg masses in the tidal wetlands died. Forty dragon and damsel fly species were recorded and the number increased from 2012 to 2014. Thirty-two aquatic species of Hemiptera and Coleoptera were recorded in 2013 and 2014, including five endanger species, ex. Cybister brevis and Hydrophilus acuminatus. However, most wetlands have been already reclaimed and destroyed by the reconstruction of road and farmland since 2014.

Some local people had an idea to restore wetlands in the areas affected by the tsunami, because most of local people would relocate to a new area and nobody could live in the lowland. In addition, they objected the breakwater plan by Miyagi Prefecture. However, most wetlands have been totally destroyed, while the non-profit organization "Mori wa Umi no Koibito" has bought a part of disaster areas for restoration. Why did local people decide to reconstruct farmlands? Before the disaster, there was no farmer to earn money and some of farmlands had been already abandoned. Some people wanted to reconstruct them to use as a kitchen garden. If local people want to reconstruct former land uses in the disaster areas, the government fully support till the end of fiscal year 2015. From 2016 a part of expenses should be charged to the municipality, because the government will change the policy for reconstruction. This is the reason why the municipality enforces local people to decide reconstruction plans as soon as possible. They have no enough time for discussion. Most people in Moune might understand the importance of wetlands through our researches, but it was difficult to build a consensus for limited time.

O7 - IPBES Regional Assessment Africa: first-hand insights into the status quo

Katja Heubach

Helmholtz-Zentrum für Umweltforschung GmbH – UFZ, Leipzig

As a part of its work programme 2014-2018, IPBES provides a set of regional/subregional assessments on biodiversity and ecosystem services (one each for Africa, the Americas, Asia-Pacific and Europe/Central Asia). In this talk first-hand insights into the drafting process of the Africa assessment will be given by a member of the expert group: What are the specific issues covered by the assessment? Who is taking part and how balanced is the author group in terms of disciplines, gender and knowledge system? What are further steps and activities? How is the assessment linked to other IPBES processes, particularly the global assessment on IPBES? These and more questions will be addressed during the talk.

END OF SESSION 31

Session 32 - Ecological and socioeconomic functions of tropical rainforest transformation systems

Short title: Rainforest transformation systems

CHAIR: DR. ANA MEIJIDE

O1 - EFForTS: Evaluating ecological and socioeconomic functions of tropical lowland rainforest transformation systems in Sumatra, Indonesia

Stefan Scheu[1]

[1]University of Göttingen, Göttingen, DE, sscheu@gwdg.de

The talk introduces the Collaborative Research Centre (CRC) "Ecological and socioeconomic functions of tropical lowland rainforest transformation systems in Sumatra (Indonesia)" which has been launched in 2012. The project aims at providing knowledge-based guidelines on how to protect and enhance the ecological functions and services of tropical forests and agricultural land-use systems at a landscape scale, while improving human welfare at the same time. The following major questions are addressed:

What are the driving forces for deforestation and the establishment of different agricultural land-use systems, and which factors contribute to the preservation of functions of tropical lowland rainforest in an agricultural landscape?

What are the functions and services of transformed land-use systems, such as rubber and oil palm plantations?

How can the ecological and socioeconomic functions and services of tropical lowland rainforest land-use systems be improved?

For answering these questions a research platform has been established comprising replicated sites of rainforest, rubber and oil palm plantations in two landscapes (Harapan Rainforest and National Park Bukit Duabelas) in the province of Jambi (Sumatra). In a comprehensive way environmental processes and biodiversity above- and below the ground are investigated. Closely associated socioeconomic projects investigate aspects of human welfare at different levels of resolution, such as household, village and province. For more detailed analyses of certain aspects of the investigated trade-off between conservation and human welfare needs a large gap enrichment experiment has been established in oil palm plantations. With the complementary approaches the CRC investigates in a unique way ecological and economic trade-offs in one of the most dynamic regions of the world and provides knowledge for coping with these dynamics in a sustainable way improving both conservation and human welfare needs.

O2 - Land-use choices, profitability, and consequences for biodiversity and ecological functions in Indonesian smallholder landscapes

Yann Clough[1,4], Vijesh Krishna[2], Marife D. Corre[3], Kevin Darras[4], Lisa Denmead[4], Ana Meijide[5], Stefan Moser[2], Oliver Musshoff[2], Stefanie Steinebach[6], Edzo Veldkamp[3], Kara Allen[3], Andrew David Barnes[7], Ulrich Brose[7], Damayanti Buchori[8], Rolf Daniel[17], Idham Haradap[8,15], Dietrich Hertel[11], Anna Mareike Holtkamp[2], Elvira Hörandl[9], I Nengah Surati Jaya[8], Malte Jochum[7], Bernhard Klarner[7], Alexander Knohl[5], Martyna Kotowska[11], Valentyna Krashevska[7], Holger Kreft[10], Mark Maraun[7], Syahrul Kurniawan[3], Christoph Leuschner[11], Nicole Opfermann[9], Dian Melati[12], César Perez[12], Walesa Edho Prabowo[13], Katja Rembold[10], Akhmad Rizali[8,14], Ratna Rubiana[8], Dominik Schneider[17], Sri Sudarmiyati Tjitrosoedirdjo[15], Aiyen Tjoa[16], Teja Tscharntke[4], Stefan Scheu[7]

[1]CEC, Lund, SE, yann.clough@cec.lu.se
[2]Department of Agricultural Economics and Rural Development, Göttingen, DE
[3]Soil Science of Tropical and Subtropical Ecosystems, Göttingen, DE
[4]Agroecology, Göttingen, DE, yann.clough@cec.lu.se
[5]Bioclimatology, Göttingen, DE
[6]Ethnology, Göttingen, DE
[7]J.F. Blumenbach Institute of Zoology and Anthropology, Göttingen, DE
[8]IPB, Bogor, ID
[9]Department of Systematics, Biodiversity and Evolution of Plants, Göttingen, DE
[10]Biodiversity, Macroecology, and Conservation Biogeography, Göttingen, DE
[11]Plant Ecology and Ecoystem Research, Göttingen, DE
[12]Forest Inventory and Remote Sensing, Göttingen, DE
[13]Institute of Ecology and Evolution, Bern, CH
[14]Brawijaya University, Malang, ID
[15]SEAMEO BIOTROP, Bogor, ID
[16]Tadulako University, Palu, ID
[17]Dept. of Genomic and Applied Microbiology, Göttingen, DE

Smallholder-dominated tropical mosaic landscapes have been suggested to be jointly beneficial for human well-being, biodiversity and ecosystem services. The persistence of biodiversity and ecosystem service delivery in these novel landscapes is uncertain as it depends on the land-use dynamics and the contribution of the dominant land-uses to ecosystem functions. Here, we quantify land-use change and the trade-offs among economic and ecological benefits between the different land-uses for smallholder-dominated landscapes of lowland Sumatra, consisting of forest remnants, oil palm, rubber monocultures and jungle rubber agroforests. Forest and jungle rubber have largely been replaced by more profitable monocultures, and in a context of expanding smallholder farm area, oil palm increasingly becomes attractive due to its reliance on material inputs over human labor. The economic benefits were in stark contrast with most ecosystem function indicators. Both oil palm and rubber monocultures had low naturalness, biodiversity and carbon stocks values compared to forests and agroforests, while oil palm stands out due to high nutrient leaching fluxes, threatening freshwater. While the complementarity in ecological and economic functions of forests, rubber agrofor-

ests, and the monocultures of rubber and oil palm suggest these could, in principle, be combined to balance multiple ecosystem services, under the current conditions smallholders are to a large extent choosing high profit – low ecological value systems.

O3 - Rainforest conversion in Sumatra‘s tropical lowlands severely reduces carbon stocks and carbon residence time in vegetation

Martyna M. Kotowska[1], Christoph Leuschner[1], Triadiati Triadiati[2], Dietrich Hertel[1]

[1]Department of Plant Ecology and Ecosystems Research, University of Göttingen, Göttingen, DE, mkotows@gwdg.de
[2]Department of Biology, Bogor Agricultural University, Bogor, ID

Tropical countries experience intensive land-use change driven by population growth and rising resource demand. The recent increase of rubber and particularly oil palm plantation establishment mainly in Indonesia is accompanied by a large gap in knowledge on regional and global implications of this conversion for ecosystem services and the carbon cycle. Therefore, in this detailed study we quantified above- and belowground carbon pools in biomass and net primary production (NPP). We examined leaf litterfall, root litter production as well as stem wood growth in natural old-growth forests, rubber agroforests under natural shade tree cover ('jungle rubber'), rubber monocultures, and oil palm plantations in Jambi province, Sumatra (32 plots in total). Total biomass in the natural forest stands (mean: 389 Mg ha^{-1}) was more than two times higher than in jungle rubber stands (149 Mg ha^{-1}) and more than four times higher than in monoculture rubber (81 Mg ha^{-1}) and oil palm plantations (56 Mg ha^{-1}). Furthermore, carbon sequestration via NPP was strongly affected as in monoculture plantations more than 50 % of assimilated carbon was removed by harvesting. Simultaneously the seasonality of NPP was increased with increasing land-use intensity as we found an increased coefficient of variance for nearly all components of NPP. Following forest conversion not only total carbon stocks were reduced by up to 166 Mg C ha^{-1} (80 % of initial value), but also carbon residence time (i.e. biomass:NPP) was 3-10 times higher in the natural forest than in rubber and oil palm plantations.

O4 - Soil nitrogen-cycling responses to conversion of lowland forests to oil palm and rubber plantations in Sumatra, Indonesia

Kara E. Allen[1], Marife D. Corre[1], Aiyen Tjoa[2], Edzo Veldkamp[1]

[1]Soil Science of Tropical and Subtropical Ecosystems, Georg-August University Goettingen, Goettingen, DE, kara.allen@forst.uni-goettingen.de
[2]Fakultas Pertanian, Agroforestry Centre, Universitas Tadulako, Palu, ID

Rapid deforestation in Sumatra, Indonesia is presently occurring for expansion of

palm oil and rubber production, for which global demand is increasing. Our study aimed to assess changes in soil-N cycling rates with conversion of forest to oil palm and rubber plantations. In Jambi Province, Sumatra, Indonesia, we selected two soil landscapes – loam and clay Acrisol soils – each with four land-use types: lowland forest and forest with regenerating rubber (hereafter, jungle rubber) as reference land uses, and rubber and oil palm as converted land uses. Gross N-cycling rates were measured using the ^{15}N pool dilution technique with in-situ incubation of soil cores. In the loam Acrisol soil, where fertility was low, microbial biomass, gross N mineralization and NH_4^+ immobilization were also low and no significant changes were detected with land-use conversion. The clay Acrisol soil which had higher initial fertility based on the reference land uses (i.e. higher pH, organic C, total N, effective cation exchange capacity (ECEC) and base saturation) ($P \leq 0.05$–0.09) had larger microbial biomass and NH_4^+ transformation rates ($P \leq 0.05$) compared to the loam Acrisol soil. Conversion of forest and jungle rubber to rubber and oil palm in the clay Acrisol soil decreased soil fertility which, in turn, reduced microbial biomass and consequently decreased NH_4^+ transformation rates ($P \leq 0.05$–0.09). This was further attested by the correlation of gross N mineralization and microbial N with ECEC, organic C, total N (R = 0.51–0. 76; $P \leq 0.05$) and C:N ratio (R = -0.71 – -0.75, $P \leq 0.05$). NH_4^+ transformation rates were lowest in unfertilized rubber and intermediate in fertilized oil palm. Our findings suggest that the larger the initial soil fertility and N availability, the larger the reductions upon land-use conversion. Because soil N availability was dependent on microbial biomass, management practices in converted oil palm and rubber plantations should aim at augmenting microbial biomass.

O5 - Root fungal communities along a tropical land-use gradient (Sumatra, Indonesia)

Josephine Sahner[1], Nur Edy[1,2], Nicole Brinkmann[1], Sri Wilarso Budi[3], Henry Barus[2], Marike Meyer[4], Andrea Polle[1]

[1]Georg-August-University, Dept. of Forest Botany and Tree Physiology, Göttingen, DE, jsahner@gwdg.de
[2]Tadulako University, Dept. of Agrotechnology, Palu, ID
[3]Bogor Agricultural University, Dept. of Silviculture, Bogor, ID
[4]Georg-August-University, Institute for Geography, Göttingen, DE

Mycorrhizal fungi form mutualistic interactions with plant roots. This symbiosis plays a critical role for ecosystem functioning as it supplies nutrients and water to the aboveground compartments of plants and acts as main pathway of carbon to soil. The influence of land-use intensification in tropical ecosystems on root fungal diversity is not well understood. We hypothesize that the loss in plant species diversity resulting from the transformation of rain forests into intensely managed plantations leads to a loss in root fungal diversity.

The study was conducted in the province of Jambi (Sumatra), which is one of the key areas for palm oil production in Indonesia. Sampling sites were chosen along a land-use gradient representing unmanaged rain forests, less-managed jungle-rubber agroforests and intensely managed mono culture rubber (*Hevea brasiliensis*) and oil palm (*Elaeis guineensis*) plantations. Root samples were analyzed by 454 pyrosequencing. Fungal operational taxonomic units (OTUs) were characterized using internal transcribed spacer (ITS) regions, ITS1 and ITS2. Environmental properties (soil carbon (C) and nitrogen (N) concentrations) and root traits were measured (nutrient status, ectomycorrhizal (EM) and arbuscular mycorrhizal (AM) colonization).

EM fungi were rare and only found in jungle-rubber and rain forest sites. AM colonization did not differ between land-use systems. Nutrient concentrations in pooled root samples were lower in oil palm plantations. Roots in oil palm plantations showed an accumulation of aluminium which was linked with a degradation of root health. Soil C and N concentrations decreased with increasing intensification of land-use. Data on the relationship between land-use intensity, root nutrient concentrations, environmental properties and root fungal diversity will be reported.

O6 - Impacts of deforestation for tree cash-crop plantations on soil organic carbon: a pan-tropic study

Oliver van Straaten[1], Marife D Corre[1], Katrin Wolf[1,2], Martin Tchienkuoa[3], Eloy Cuellar[4], Robin Matthews[5], Edzo Veldkamp[1]

[1]Gerog-August-University of Goettingen, Goettingen, DE, ostraat@gwdg.de
[2]Atmosfair gGmbH, Berlin, DE
[3]Institut de Recherche Agricole pour le Développement (IRAD), Yaoundé, CM
[4]Instituto Nacional de Investigación Agraria (INIA), Lima, PE
[5]The James Hutton Institute, Aberdeen, UK

Tropical deforestation for the establishment of tree cash-crop plantations causes significant alterations to soil organic carbon (SOC) dynamics. In this pan-tropic study, conducted in regions of active deforestation in Indonesia, Cameroon and Peru, we quantified the impact the conversion of forests to oil palm (*Elaeis guineensis*), rubber (*Hevea brasiliensis*) and cacao (*Theobroma cacao*) plantations has on SOC stocks in the top 3-m of soil. Additionally, we investigated the biophysical controls regulating SOC stocks and SOC stock changes. Using a space-for-time substitution approach, we compared SOC stocks in deeply-weathered mineral soils from paired forests (n = 32) and adjacent tree cash-crop plantations (n = 54). Our study showed that SOC concentrations are controlled by clay content, soil density, soil pH and precipitation. Furthermore, deforestation for tree plantations can result in a loss of more than half of the original SOC stocks depending on the initial carbon stock in the forest prior to deforestation. Essentially meaning that the higher the SOC is initially the greater the carbon loss. The decreases in SOC stocks were most pronounced in the topsoil, although older plantations showed considerable SOC loss below 1-m depth, where between 50-60% of SOC stocks in the top 3-m is stored. These results highlight: 1) the need for land-use managers and policies to protect natural forests located on mineral SOC hotspots to mitigate carbon losses and 2) that the emission factor recommended by the Intergovernmental Panel on Climate Change for forest conversion to perennial tree plantations need to be revised to improve GHG accounting.

O7 - Land-use intensification to oil palm directly restructures whole ecosystems

Kara Allen[1], Andrew Barnes[1], Marife Corre[1], Edzo Veldkamp[1], Yann Clough[2], Rolf Daniel[1], Kevin Darras[1], Lisa Denmead[1], Dietrich Hertel[1], Malte Jochum[1], Alexander Knohl[1], Martyna Kotowska[1], Holger Kreft[1], Syahrul Kurniawan[1], Ana Meijide[1], Katja Rembold[1], Dominik Schneider[1], Teja Tscharntke[1], Ulrich Brose[1,3,4]

[1]University of Goettingen, Goettingen, DE
[2]Lund University, Lund, SE
[3]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE
[4]Friedrich Schiller University Jena, Jena, DE

Changes in plant community structure have a strong influence on the diversity and biomass of higher trophic levels. Consequently, the presently ensuing large-scale changes in plant communities resulting from tropical forest conversion to rubber and oil-palm agriculture will likely alter a large range of taxa at higher trophic levels. Previous research has shown that tropical land-use change has severe consequences for biodiversity and ecosystem functioning of animal communities. However, little is known about whether these responses are driven by direct land-use effects or by bottom-up trophic cascades mediated by changes in plant communities. With data collected from a multi-taxa research initiative in Indonesia, we use structural equation modelling to disentangle direct land-use effects from indirect plant-mediated effects on above- and below-ground taxa including microbes, invertebrates and birds. Partitioning effects into those caused by land-use change and abiotic factors (direct effects), as well as biotic interactions (indirect effects), we establish how land-use conversion to plantation agriculture alters multi-taxa biodiversity and biomass. We find that while cascading bottom-up effects play a role in structuring communities at higher trophic levels, land-use change to oil-palm agriculture dominates in terms of the number and strength of impacts on ecological communities by directly altering all taxa that were sampled. Our study reveals the importance of direct land-use effects for driving large-scale ecological shifts and shows that, if conservation efforts for whole ecosystems are to be effective, this will require a direct management focus at all trophic levels.

O8 - Litter macro-invertebrate community responses to consumer-resource stoichiometric imbalance

Malte Jochum[1], Andrew Barnes[1], Achmad Farajallah[2], Stefan Scheu[1], Ulrich Brose[1,3,4]

[1]University of Goettingen, Goettingen, DE, mjochum@gwdg.de
[2]Bogor Agricultural University (IPB), Bogor, ID
[3]German Centre for Integrative Biodiversity Research (iDiv), Halle, DE
[4]Friedrich Schiller University Jena, Jena, DE

Living organisms are dependent on both resource quantity and quality. Ecological stoichiometry offers important insights into how the elemental composition of resources might affect their consumers. If resource quality changes, consumers must respond in order to maintain their dietary requirements. The consumer community can respond to resource depletion with a shift in body stoichiometry, by avoiding low-quality resources, or through compensatory feeding. We analyzed consumer body-stoichiometry, species richness, biomass and energy flux of multiple trophic levels along a resource-quality gradient in tropical decomposer systems. We did not detect shifts in consumer body stoichiometry, or decreases in consumer biomass in response to declining resource quality. However, when scaling assimilation efficiency with consumer-resource stoichiometric imbalance, we found that energy fluxes to detritivores were higher in low-quality resource habitats. Consequently, predators did not exhibit any change in these variables since their resource amount and quality did not change. Furthermore, we found that detritivore species richness was dependent on basal resource quality, which yielded indirect effects on predator species richness. As such, we demonstrate that the depletion of resource quality can directly and indirectly alter consumer communities across multiple trophic levels.

O9 - Effects of ant exclusion on above- and below-ground invertebrate communities and associated ecosystem processes across land-use systems.

Lisa Helen Denmead[1], Yann Clough[1,2], Ingo Grass[1], Bernhard Klarner[3], Valentyna Krashevska[3], Akhmad Rizali[4], Stefan Scheu[3], Teja Tscharntke[1]

[1]Agroecology, University of Goettingen,, Göttingen, DE, ldenmea@gwdg.de
[2]Centre for Environmental and Climate Research, Lund, SE
[3]J.F. Blumenbach Institute of Zoology and Anthropology, University of Goettingen, Göttingen, DE
[4]Department of Plant Pests and Diseases, Faculty of Agriculture, University of Brawijaya, Malang, ID

Ants make up an estimated 15% of the total terrestrial animal biomass. Furthermore, ants carry out a wide range of important ecosystem processes such as predation, seed dispersal, soil aeration and pollination and therefore can strongly influence plant and above and belowground invertebrate communities. Ant exclusion

experiments can help us understand the role of ants in ecosystem processes, but have up until now mostly focused on above-ground communities and herbivory, whereas research on below-ground communities and associated ecosystem processes, such as decomposition is lacking. Also, little is known about the changes in the relative influence of ants on ecosystems with habitat transformation. To investigate the influence of ants on both above- and below-ground invertebrate communities and associated ecosystem processes across different land-use systems we created paired ant exclusion and control plots (six 1.5 m x 1 m plots per site) in 16 lowland forest, jungle rubber, rubber and oil palm sites (four in each system) in Sumatra, Indonesia. We assessed the vegetation before and after one year of exclusion, extensively surveyed both above- and below-ground invertebrates and measured decomposition rates within the experiment plots. We perform structural equation modelling to disentangle the relationships between ants and the measured response variables, assess the overall impact of ants in the study systems and compare the relative effects of ants between land-use systems. We hypothesise ant exclusion will have a negative impact on vegetation through decreased seed dispersal, but will lead to an increased abundance of other invertebrate groups due to a release from ant predation which in turn could influence decomposition rates. The final analyses will provide much needed information on the relative influence of ants on both above- and below-ground communities and changes to ecosystem processes following rainforest transformation.

O10 - Bird Diversity, Functions and Services across Indonesian land-use systems

Kevin Darras[1], Lisa Denmead[1], Walesa Edho Prabowo[5], Patrick Diaz[2], Arite Hildebrandt[1], Fransica Noni[3], Yeni Mulyani[3], Dewi Prawiradilaga[4], Yann Clough[1], Teja Tscharntke[1]

[1]Georg-August University of Göttingen, Göttingen, DE, kdarras@gwdg.de
[2]University of Jambi, Jambi, ID
[3]Bogor Agricultural University (IPB), Bogor, ID
[4]Institute of Sciences (LIPI), Cibinong, ID
[5]University of Bern, Bern, CH

Tropical rainforests worldwide have suffered heavy losses and are undergoing major transformations. We focus on birds in two major land-use systems - oil palm and rubber plantations - in Jambi province, on the island of Sumatra, Indonesia.

Using sound recordings, point counts and mist netting, we uncover bird diversity trends along the transformation gradient over more than a hundred sites. We demonstrate the necessity of measuring sound detection spaces when using acoustic biodiversity monitoring. We trace the change in ecological function using classic functional indices and contrast that to consumer-resource networks. To link bird function to real-world agricultural systems, we designed bird and ant exclosure experiments in young, productive oil palm plantations and trace the change in yield over more than a year while measuring predation, herbivory, and baseline diversity data.

Our results show the profound changes in bird diversity, function, and services after rainforest transformation. Bird activity trends however, are even more drastic. Functionally, frugivores are lost, insectivores decline, and omnivores thrive; but interestingly, consumer-resource networks become more specialized in disturbed systems. Bird ecosystem services in oil palm are still an unknown since our exclosures yielded variable effects. However our results suggest that in our disturbed systems, birds might exert only generalistic predator pressure rather than direct biocontrol.

O11 - Ecological restoration in an oil palm landscape: early performance of trees planted in a biodiversity enrichment experiment

Anne Gérard[1], Miriam Teuscher[1], Bambang Irawan[2], Yann Clough[3], Ulrich Brose[1], Dirk Hölscher[1], Holger Kreft[1]

[1]Georg-August-Universität Göttingen, Göttingen, DE, agerard@forst.uni-goettingen.de
[2]University of Jambi, Jambi, ID
[3]Lund University, Lund, SE

Transformation of rainforest into large-scale mono-cultural oil palm plantations has led to dramatic losses in biodiversity and ecological functions. While there is broad consensus that the re-establishment of diverse habitats and the restoration of ecological multi-functionality in oil palm-dominated landscapes is an urgent need, there is little theoretical and applied knowledge on how this can be implemented in a way that is ecologically and economically equally effective.

In order to investigate the underlying mechanisms of applied biodiversity enrichment, we established 48 experimental tree islands (56 plots including controls) within a large-scale mono-cultural oil-palm plantation in the province of Jambi (Sumatra, Indonesia) in December 2013. We systematically varied plot size (5x5m, 10x10m, 20x20m, 40x40m) as well as species diversity and composition of a total of six multi-purpose tree species native to Sumatra. We applied a random partitions design with four partitions series (tree diversity levels of six, three, two and one) plus four plots without planting subject to natural succession and four control plots. Over the first 18 months of the experiment, we monitored mortality as well as diameter and height increment of the planted trees.

After the first 18 months, we report a successful establishment of the experiment. Overall mortality rate was 26% (1649 of the 6354 initially planted trees), but varied significantly among the species (ranging from 16 to 52%). We found significant differences in height and diameter increment among the species (means of relative growth rates ranged between 270 and 620% for height and 280 and 700% for diameter). Tree species composition, plot size and intra- and interspecific competition does not appear to significantly affect tree survival and growth at this early stage of the experiment. However, in the near future, we expect a shift of the main factors driving the establishment success and growth trajectories. Based on the different establishment successes among the tree species, we discuss their suitability for an enrichment planting in oil palm plantations after the critical establishment phase.

O12 - Combining socio-economic and ecological functions in modelling lowland rainforest transformation

Johannes Heinonen[1,2], Claudia Dislich[1], Elisabeth Hettig[1,3], Jann Lay[1,3], Katrin Meyer[1], Kerstin Wiegand[1]

[1]University of Göttingen, Göttingen, DE, jheinon@gwdg.de
[2]University of Aberdeen, Aberdeen, UK, jheinon@gwdg.de
[3]GIGA-German Institute of Global and Area studies, Hamburg, DE

The loss of tropical rainforest in Indonesia has been linked to the spread of agricultural systems such as rubber and oil palm industries. The economic and ecological aspects of these systems are inextricably linked. In order to inform management for finding a balance of ecosystem functions and economic benefits, we developed a spatially-explicit, agent-based model to simulate spatiotemporal dynamics of land uses and individual households. Our results indicate some of the trade-offs that can occur between ecosystem functions such as carbon storage and economic benefits.

P1 - Carbon dioxide and methane fluxes in a tropical landscape converted from lowland forest to rubber and oil palm plantations

Evelyn Hassler[1], Marife D. Corre[1], Muhammad Damris[2], Aiyen Tjoa[3], Sri Rahayu Utami[4], Edzo Veldkamp[1]

[1]University of Göttingen, Göttingen, DE, epreuss@gwdg.de
[2]Jambi University, Jambi, ID
[3]Tadulako University, Palu, ID
[4]Brawijaya University, Malang, ID

Expansion of palm oil and rubber production, for which global demand is increasing, causes rapid deforestation in Sumatra, Indonesia and is expected to continue in the next decades.Our study aimed to 1) quantify changes in soil CO_2 and CH_4 fluxes with land-use change, and 2) determine their controlling factors. InJambi Province, Sumatra, Indonesia, we selected two landscapes on heavily weathered soils that differ mainly in texture: loam and clay Acrisol soils. At each landscape, we investigated the reference land uses forest and secondary forest with regenerating rubber (termed as jungle rubber), and the converted land uses rubber (7-17 years old) and oil palm plantations (9-16 years old). We measured soil CO_2 and CH_4 fluxes monthly from December 2012 to December 2013. Soil CO_2 fluxes from the oil palm decreased compared to the other land uses ($P<0.01$). Across land uses, annual CO_2

fluxes were correlated positively with soil organic C and negatively with ^{15}N signatures, extractable P and base saturation. This suggests that the reduced soil CO_2 fluxes from oil palm was a result of strongly decomposed soil organic matter due to reduced litter input, and possible reduction in C allocation to roots due to improved soil fertility from liming and P fertilization in these plantations. Reduction in soil CH_4 uptake in the converted land uses compared to the reference land uses (P<0.01) were primarily caused by the decrease in soil N availability in these converted land uses. Our study shows for the first time that differences in soil fertility control soil-atmosphere exchange of CO_2 and CH_4 in a converted tropical landscape, a mechanism that we were able to detect by conducting this study at the landscape scale.

P2 - Nutrient leaching losses in smallholder oil palm plantations in Sumatra, Indonesia

Syahrul Kurniawan[1,2], Marife D. Corre[1], Sri Rahayu Utami[2], Edzo Veldkamp[1]

[1]Soil Science Tropical and Subtropical Ecosystems - Büsgen Institute, Georg-August University of Göttingen, Goettingen, DE, skurnia@gwdg.de; kurniawan_syahrul@yahoo.com
[2]Department of Soil Science, Faculty of Agriculture, Brawijaya University, Malang, ID, skurnia@gwdg.de; kurniawan_syahrul@yahoo.com

Forest conversion to agriculture increases nutrient leaching losses due to changes in rooting depth, soil nutrient availability and management practices. Our study aimed to quantify nutrient leaching losses from fertilized area and under frond stack in oil palm plantations in Jambi Province, Sumatra, Indonesia. We selected four sites of smallholder oil palm plantations (9-16 years old) in each of the two landscapes on highly weathered soils that differed mainly on texture: loam and clay Acrisol soils. We measured nutrient leaching using suction cup lysimeters, installed on fertilized area (at 1 m distance from the palm tree) and under frond stack (at 4.5 m distance from the palm tree) at 1.5-m soil depth, which was well below the rooting depth. We collected soil water on bi-weekly to monthly interval from February to December 2013. Water drainage flux was estimated using a water model, parameterized with site conditions and validated with field measurements. In the loam Acrisol, NH_4^+-N, dissolved organic C (DOC), Ca, Mg, Na, total Al, total Mn, total S and Cl leaching fluxes were higher in fertilized than frond stack areas (all $P \le 0.05$, except $P \le 0.07$ for Na, total Mn and total S) whilst in the clay Acrisol K leaching fluxes were higher in fertilized than frond stack areas ($P = 0.06$). The large leaching losses of N, Ca, Mg, Na, K and Cl in fertilized areas were due to chemical fertilizers and lime that released these nutrients more than those from frond decomposition. The high Al leaching losses in fertilized areas may have resulted from the decreased soil solution pH ($P = 0.08$) due to N fertilization, increasing Al solubility in this Acrisol soil that had low initial buffering capacity. The lower DOC leaching losses under the frond stack suggest higher DOC retention and/or lesser DOC production than in fertilized area. In the loam Acrisol, leaching fluxes of NH_4^+-N, DOC, Na, and total S were correlated positively with soil pH and base saturation (BS) of the soil (all $P \leq 0.03$) whilst in the clay Acrisol K and Mg leaching fluxes were marginally correlated with BS (all $P = 0.06$). Our results showed that the management practice by smallholders of ring fertilization around oil palm trees could affect ground water quality. This calls for improved management practices, which optimize yield, minimize leaching losses and conserve long-term fertility.

P3 - Biodiversity enrichment in oil palm plantations - taxonomic diversity response of birds and arthropods

Miriam Teuscher[1], Anne Gérard[1], Bambang Irawan[3], Dirk Hölscher[1], Holger Kreft[1], Yann Clough[1,4], Ulrich Brose[1,2]

[1]Georg-August-Universität Göttingen, Göttingen, DE, mteusch@gwdg.de
[2]German Centre for Integrative Biodiversity Research, Leipzig, DE
[3]Univeristy of Jambi, Jambi, ID
[4]University of Lund, Lund, SE

Global land-use change has drastic consequences for biodiversity leading to losses of ecological functioning and ecosystem services. Re-establishing diverse habitats by restoring ecological multi-functionality in oil palm landscapes has been proposed. However, theecologicalandeconomicalprocesses associated to this are largely unknown.

To bridge this gap, we established 48 experimental tree islands within a large-scale, mono-cultural oil-palm plantation in the province of Jambi (Sumatra, Indonesia) in December 2013. Plot size as well as species diversity and composition of six multipurpose tree species native to Sumatra were systematically varied. We followed a random partitions design with four partitions series (tree diversity levels of six, three, two and one) plus four plots without planting subject to natural succession. This combined biodiversity ecosystem functioning and enrichment planting experiment addresses the question whether or not biodiversity and associated ecosystem services can be restored by enrichment planting.

Monitoring on ecological processes includes diversity and abundance of birds and invertebrates in the leaf litter and herb layer. The samplings of these groups were done before and ten months after the establishment of the experiment.

Preliminary results indicate that tree species identity and composition have not had a significant effect on the diversity and abundance of birds, herb layer and leaf litter invertebrates. Plot size, however, explains significant changes in the diversity of leaf litter invertebrates but not in their abundance. Diversity and abundance of birds and herb layer invertebrates were not affected by plot size.

Based on further results, we aim to evaluate the effectiveness of these enrichment plantings to contribute to the development of ecologically improved management concepts in oil palm landscapes.

P4 - Functional diversity and stability of litter-invertebrate communities following tropical land-use change

Steffen Mumme[1], Malte Jochum[1], Ulrich Brose[1,2,3], Noor Farikhah Haneda[4], Andrew D. Barnes[1]

[1]University of Goettingen, Goettingen, DE, steffen.mumme@gmx.net
[2]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE
[3]Friedrich Schiller University Jena, Jena, DE
[4]Bogor Agricultural University, Bogor, ID

Tropical land-use intensification is rapidly increasing in regions that harbor high levels of biodiversity, thus posing a serious threat to the stability and resilience of tropical ecosystems and the important ecosystem services that they provide. We compared functional group richness and functional dispersion in litter-invertebrate communities among four different land-use systems, ranging in intensity from secondary tropical forest to oil-palm agriculture in two landscapes on Sumatra, Indonesia. We then investigated the consequences for functional stability and community resilience by calculating functional redundancy and response diversity of sampled communities. From secondary forest to intensively managed oil-palm systems, we found a 46 % decrease in species richness and density but weaker effects on functional group richness and an increase in functional dispersion. Although we detected no significant alteration of response diversity, functional redundancy of litter-invertebrate communities decreased clearly by losing roughly half of functionally redundant species due to land-use change. Our results indicate that land-use change, from tropical rainforest to oil-palm agriculture, can alter both taxonomic and functional diversity of litter-invertebrate communities, resulting in the loss of functional redundancy and thus functional stability of these ecosystems. However, we show that land-use systems of intermediate management intensity, such as jungle rubber or even monoculture rubber plantations, could serve as alternative production landscapes that harbor more similar levels of functional diversity and redundancy to lowland tropical rainforests.

P5 - From science to practice: transdisciplinary approaches for promoting balanced land use systems in Sub-Saharan Africa

Christine B. Schmitt[1,4], Kwadwo Amankwah[2], Tina Beuchelt[1], Ifidon Ohiomoba[3], Manfred Denich[1]

[1]Center for Development Research (ZEF), University of Bonn, Bonn, DE, christine.schmitt@landespflege.uni-freiburg.de

[2]Kwadaso College of Agriculture, Kumasi, GH
[3]Forum for Agricultural Research in Africa (FARA), Accra, GH
[4]Chair for Landscape Management, University of Freiburg, Freiburg, DE, christine.schmitt@landespflege.uni-freiburg.de

Unabated high rates of deforestation and forest degradation are a major issue in most tropical countries. In Ghana, for example, vast forest areas have been cleared for agriculture. The remaining forests are impacted by slash-and-burn practices and are under pressure from charcoal production for everyday energy needs. The selling of charcoal also provides an additional income for resource-poor farmers, underlining the link between food and non-food biomass production and deforestation. Against this background, the research project BiomassWeb has the objective to promote biomass production, processing and trading in Ghana, Nigeria and Ethiopia in order to contribute towards more sustainable, productive and efficient land use systems. Furthermore BiomassWeb aims to ensure that research results will lead to actual changes on the ground. This is facilitated by integrating stakeholders in the research countries as early as possible through transdisciplinary demand-driven research and development (DDRD) activities and the initiation of a pan-African expert network, called BiomassNet. The DDRD activities are a flexible, grant-based programme complementing the ongoing research in the African target countries. A first call for proposals has just been issued. BiomassNet is an interactive, internet-based network, which will link up African scientist, experts, policy makers, authorities, development organisations and practitioners to strengthen the biomass sector at local, national and continental level. The network is being jointly established with African partners with Ghana as a starting point. First experience from setting up the network will be used to highlight the diversity of stakeholder groups involved in tackling biomass-related land use issues and the need for targeted recommendations for policy and practice.

END OF SESSION 32

Session 33 - Macroecology and macroevolution: investigating diversity in space and time

Short title: Macroecology and macroevolution

CHAIR: DR. JULIANO SARMENTO CABRAL, PROF. DR. SUSANNE FRITZ

O1 - Combining macroecological and macroevolutionary approaches to evaluate richness patterns in Neotropical birds

Catherine Graham[1], Marisa Lim[1]

[1]Stony Brook University, Stony Brook, US, catherine.graham@stonybrook.edu

Spatial patterns of biodiversity are generated by many processes, which include abiotic, biotic, and temporal dimensions; however, it can be difficult to integrate several lines of evidence into a single framework. Here, we propose a framework for combining information about the diversification history (phylogeny), biogeography (geographic distribution), and ecology (climatic niche) of species to better evaluate the processes that promote spatial patterns of biodiversity. We explore our framework by examining species diversity in several groups of Neotropical birds which occur throughout the Americas and are taxonomically, morphologically, and behaviorally diverse.

O2 - The origin of species richness patterns along environmental gradients

Mikael Pontarp[1]

[1]University of Zurich, Zurich, CH

Patterns of species richness, such as the remarkable biodiversity of tropical regions, have been documented and studied for centuries, but their underlying evolutionary and ecological causes remain poorly understood. An increasingly common paradigm is that high richness in some habitats is caused by one of three competing explanations: habitats with higher richness have either (i) higher carrying capacity, (ii) greater time for speciation (earlier colonization), or (iii) foster more rapid diversification rates (faster speciation relative to extinction). However, these three explanations are largely unstudied theoretically, and empirical studies give conflicting results about their relative importance. Here, we use individual-based eco-evolutionary modeling to study the processes that drive richness patterns along environmental gradients. Contrary to the common paradigm, we find that variation in carrying capacity can underlie both diversification rates and time, and is therefore not a competing, alternative explanation. We also find that the time-for-speciation effect dominates richness patterns over short time scales, whereas diversification rates dominate over longer time scales. These observations can help reconcile the seemingly conflicting results of many empirical studies, which find that some patterns are explained by time and others by differences in diversification rates.

O3 - Multi-scale biodiversity patterns in relation to elevation, disturbance and alien species

Sylvia Haider[1], Aníbal Pauchard[2], Christoph Kueffer[3]

[1]Martin Luther University Halle-Wittenberg, Institute of Biology, Geobotany and Botanical Garden, Halle (Saale), DE, sylvia.haider@botanik.uni-halle.de
[2]Universidad de Concepción, Facultad de Ciencias Forestales, Concepción, CL
[3]ETH Zurich, Institute of Integrative Biology - Plant Ecological Genetics, Zurich, CH

Explaining spatial variation in biodiversity along environmental gradients is an important research question. However, few studies have investigated the relation among local species richness (α-diversity) and community change (β-diversity) or how they contribute to regional species richness (γ-diversity) with field data collected across a large geographical extent.

Elevation gradients are useful model systems to study systematically the response of α-, β- and γ-diversity to changing environmental conditions interacting with other natural or human induced factors. We present a global analysis of plant species diversity - including native and alien species - that is based on a systematic survey in nine mountain regions from all continents (except Antarctica). We recorded the seed plants community in plots of standardized size and equal spread along the maximum extent of the elevation gradient. Thereby we simultaneously addressed the effect of two drivers of global change: human induced disturbance (roadsides) and alien plants.

The most common pattern of native richness along the elevation gradient was a positive unimodal distribution, while alien richness declined with elevation. Disturbance strongly changed the pattern, but inconsistently across regions. Plot similarity was higher in undisturbed plots, particularly for natives. Aliens slightly increased β-diversity in undisturbed plots, but had a homogenization effect along roads. Unexpectedly, β-diversity did not vary with elevation. Mean plot similarity was not related to regional diversity, but maximum dissimilarity increased with it. We conclude that although elevation is a major determinant in biodiversity assembly, it has very different effects on native and alien species and this effect is modulated by local disturbance. Our results emphasize the need for studies that address how biodiversity is shaped by multiple, interacting processes and how novel emerging biodiversity differs from natural patterns.

O4 - Investigating biogeographic drivers on treeline elevations - a neglected view on global patterns?

David Kienle[1], Severin D.H. Irl[1], Carl Beierkuhnlein[1]

[1]Department of Biogeography, BayCEER, University of Bayreuth, Bayreuth, DE, david.kienle@uni-bayreuth.de

Treelines are fundamental borders in ecology and have been investigated for centuries. Most studies investigated the fundamental environmental causes of treelines whereas geographic drivers such as isolation, continentality and mass elevation effect (MEE) were rarely studied but may be relevant to understand global patterns of treeline occurrence. So far the effect of isolation on treelines has been shown only for islands but it might occur on continents as well. The MEE, which ameliorates growing conditions through increased solar radiation within large mountain chains, has often been described but quantifications are still rare and often unsystematic. To evaluate the importance of these biogeographic drivers on a global scale, we sampled one of the largest treeline elevation data sets (n = 672) using an innovative and systematic sampling approach (GoogleEarth). This enables a global coverage of treeline samples (74°N to 66°S) and a quantification of the influence of isolation (i.e. the nearest distance to a mountain region with similar elevation), continentality (i.e. distance from the ocean) and MEE (i.e. area of mountain chains) on treeline elevation. The global latitudinal pattern showed a distinct double hump, which may result from a tropical depression or from the lack of high mountains in the equatorial tropics. We showed a significant decreasing of treeline elevation with increasing isolation on both, islands and continental mountains. The negative effect of isolation on treeline elevation was stronger on islands and with decreasing distances to the equator. Treeline elevations decreased with increasing continentality for treeline samples located outside of mountain chains. MEE increased treeline elevations significantly. Our results showed that MEE is the most important driver of treeline elevations beside their latitudinal location. We provide new insights into the global pattern of treeline elevations considering underrepresented biogeographic drivers.

O5 - A macroecological comparison of global animal movement patterns

Marlee Tucker[1], Thomas Mueller[1], et al.[1]

[1]Senckenberg Biodiversity and Climate Research Centre & Department of Biological Sciences, Goethe University, Frankfurt, DE, marlee.tucker@senckenberg.de

Understanding the causes and consequences of animal movements is important because any changes in movement can have both direct and indirect effects on ecosystem structure and function. There are large variations in movement patterns among animal species and this variation has been attributed to life history traits, environmental characteristics and phylogenetic relationships. Despite the abundance of movement ecology research the effects of life history, environment and phylogeny have often been studied in isolation and the majority of movement ecology studies have focused on single species, limiting our understanding of how individual movements form global movement patterns. To overcome these limitations, we followed a macroecological approach utilising the increased availability of animal tracking data to characterise global movement patterns and examine their underlying drivers. We developed a research project that includes more than 100 co-authors and data contributors to compile a data base of more than 50 mammal and 70 bird species from across the globe. We standardised relocations to set time intervals (e.g. hourly and daily) and calculated various movement measures. We also extracted life history traits and phylogenetic information from the literature, and annotated relocations using environmental data on vegetation and climate. We compare movements across taxonomic groups, different modes of movement (i.e. air, land and water), diet guilds (i.e. carnivore, omnivore and herbivore) and geographic distribution and also examine environmental influence on global movement patterns. Our findings contribute to the broad-scale understanding of animal movements and are important for understanding a range of ecological patterns including species interactions and animal responses to changing environments.

O6 - Islands are going Big Data - Towards a global synthesis of island floras

Holger Kreft[1], Patrick Weigelt[1]

[1]Biodiversity, Macroecology & Conservation Biogeography, University of Göttingen, Göttingen, DE, hkreft@uni-goettingen.de

Islands have long been in the focus of ecology and evolutionary biology; and island research has sparked some of the most influential theories in these fields. At the same time, habitat loss and invasive species put island plants at a disproportionate risk of extinction. Enormous amounts of information about species distributions, ecological preferences and phylogenetic relationships of island plants have been collected over the last decades and centuries. Most of these data, however, reside in scattered publications and databases hampering comparative, large-scale studies in island biogeography, ecology, and conservation. Truly global studies aiming at an integration and synthesis of island plant diversity are still scarce. Here, we report on recent efforts to compile a globally unique, representative database of plants on islands. We present and discuss the bio- and ecoinformatic frameworks and tools needed for data mobilization, processing, standardization and quality control. Currently, our database includes species lists for 1,088 marine islands worldwide and >250,000 occurrences of >48,000 native vascular plant species. Additionally, we compiled physical and bioclimatic characteristics for 17,883 marine islands >1 km^2 (~98% of total island area) worldwide. Together with information on species traits and phylogenetic relationships, this offers novel opportunities to gain insights into how species traits interact with physical island environments, to understand the causes of the diversity and assembly of island floras and to assess global change effects.

O7 - Do species attributes explain variation in response to climate change? A cross-taxon assessment

Diana Bowler[1], Peter Haase[2], Christian Hof[1], Ingrid Kröncke[3], Rita Adrian[4], Léon Baert[5], Hans-Günther Bauer[6], Theo Blick[7], Sami Domisch[16], Rob Brooker[8], Reiner Eckmann[9], Frederik Hendrickx[5], Thomas Hickler[1,10], Stefan Klotz[11], Alex Kraberg[12], Ingolf Kühn[11,13], Silvia Matesanz[14], Hermann Neumann[3], Bob O'Hara[1], David Russell[15], Oliver Schweiger[11], Anne Sell[17], Moritz Sonnewald[7], Stefan Stoll[2], Andrea Sundermann[2], Oliver Tackenberg[10], Michael Türkay[7], Fernando Valladares[18], Kok van Herk[19], Roel van Klink[20], Rikjan Vermeulen[21], Karin Voigtländer[15], Rüdiger Wagner[22], Erik Welk[13], Martin Wiemers[11], Karen Wiltshire[12], Katrin Böhning-Gaese[1,10]

[1]1Senckenberg Biodiversity and Climate Research Centre, Frankfurt, DE, diana.bowler@senckenberg.de
[2]Senckenberg Research Institute and Natural History Museum Frankfurt, Gelnhausen, DE
[3]Senckenberg am Meer, Wilhelmshaven, DE
[4]Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, DE
[5]Royal Belgian Institute of Natural Sciences, Brussels, BE
[6]Max Planck Institute for Ornithology, Radolfzell, DE
[7]Senckenberg Research Institute and Natural History Museum Frankfurt, Frankfurt, DE
[8]The James Hutton Institute, Aberdeen, UK
[9]Universit Konstanz, Konstanz, DE
[10]Goethe-University, Frankfurt, DE
[11]UFZ – Helmholtz Centre for Environmental Research, Halle, DE
[12]Alfred Wegener Institute for Polar and Marine Research, Helgoland, DE
[13]Martin Luther University Halle Wittenberg, Halle, DE
[14]Universidad Rey Juan Carlos, Madrid, ES
[15]Senckenberg Museum of Natural History Görlitz, Görlitz, DE
[16]Yale University, New Haven, US
[17]Thünen Institute of Sea Fisheries, Hamburg, DE
[18]Museo Nacional de Ciencias Naturales, Madrid, ES
[19]Lichenologisch Onderzoekbureau Nederland, Soest, NL
[20]Institute of Botany of the Academy of Sciences of the Czech Republic, Průhonice, CZ
[21]Willem Beijerinck Biological Station, Loon, NL
[22]Universität Kassel, Kassel, DE

We brought together 20 long-term local population datasets on different taxonomic groups in marine, freshwater and terrestrial realms within central Europe. We tested within each data set, and compared among them, the ability of species traits including temperature niche to explain long-term population trends as well as species response to annual temperatures. Temperature niche is a more consistent predictor of long-term trends in terrestrial datasets but, in general, there are few simple relationships between species attributes and their response to climate change.

O8 - The niche is not the range: the demographic basis of species' distributions

Frank Schurr[1], Martina Treurnicht[1,2], Henning Nottebrock[1], Karen J. Esler[2], Jörn Pagel[1]

[1]University of Hohenheim, Stuttgart, DE, frank.schurr@uni-hohenheim.de
[2]Stellenbosch University, Stellenbosch, ZA

The geographical ranges of species ultimately arise from the dynamic interplay of reproduction, mortality and dispersal in variable environments. To understand how small-scale demographic processes translate into large-scale range dynamics, we have to quantify (1) how demographic rates respond to environmental variation across large spatial extents, (2) how demographic variation causes large-scale variation in local population dynamics (thereby determining the niche of species sensu Hutchinson), and (3) in what way the geographical projection of the Hutchinsonian niche differs from the actual geographical range of species.

We investigated these links for 26 species of trees and shrubs from the Proteaceae family that are endemic to the South African Fynbos biome. Specifically, we quantified how mortality, fecundity and recruitment vary across the global geographical ranges of our study species. The resulting data set currently provides the most comprehensive quantification of large-scale variation in plant demography. We use these data to infer environmental effects on local population dynamics and to quantify Hutchinsonian niches as the set of 'suitable' environments in which intrinsic population growth rate is positive. We show that actual species distributions differ substantially from the geographical projection of these demographically defined niches. This mismatch arises because species are frequently absent from suitable sites and present in unsuitable sites. However, species traits determining dispersal and population persistence explain interspecific variation in the occupancy of both suitable and unsuitable environments.

In summary, this study has both a cautionary and a promising message for macroecology. On the one hand, it provides new evidence showing that the common practice of inferring niches from species' distributions is questionable. On the other hand, it highlights that a demographic understanding of range dynamics is possible.

O9 - Macrophysiology of endotherms: the global variation in thermal traits of birds and mammals

Christian Hof[1], Imran Khaliq[1]

[1]Senckenberg Biodiversity and Climate Research Centre (BiK-F), Frankfurt, DE, christian.hof@senckenberg.de

The relationships among species' thermal capacities and the geographical variation of ambient climatic conditions are of key importance to understand the distribution of Life on Earth and the responses of species to climate change. Here, we assembled data on thermal tolerances from physiological experiments of more than 500 species of birds and mammals from all over the word and analyzed them, along with data on ambient climate and species' geographical distributions in a phylogenetically and spatially explicit context. We found that thermal tolerance was a poor predictor of geographical range size, and that, overall, the ambient temperature conditions that species experience across their distributions do not match well with their thermal tolerances. Macrophysiological patterns were partly incongruent for birds and mammals – a difference which may result from different adaptive capacities via behavior, morphology or physiology. Current environmental conditions explained a larger amount of variation in thermal traits among species than their evolutionary history. However, phylogeny was much more important than current environment for explaining the variation in physiological traits in the tropics, whereas environment was more important than phylogeny in temperate species. Using species' thermal tolerances, we show that their vulnerability to climate change increases from polar to tropical regions, underlining the high sensitivity of tropical diversity to even small changes in ambient climatic conditions. However, we also show that many species may be able to tolerate projected temperature increases across significant proportions of their ranges. Our results suggest that the relationship between thermal physiology and ambient climate varies across space and between taxa. Overall, our findings underline the need for cross-disciplinary research among physiologists, ecologists, and biogeographers, to improve future projections of biodiversity in a changing world.

O10 - The role of plant functional traits and climatic niche characteristics for invasive range dynamics of weeds

Erik Welk[1,2], Maria Sporbert[1], Helge Bruelheide[1,1,2]

[1]Institute of Biology / Geobotany and Botanical Garden, Martin-Luther-University Halle-Wittenberg, Halle (Saale), DE, erik.welk@botanik.uni-halle.de
[2]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Halle, Leipzig, Jena, DE, erik.welk@botanik.uni-halle.de

Predictions of potential distributions of non-indigenous species often assume niche conservatism, yet recent analyses suggest that niche shifts can also occur. Especially successful weed species are supposed to be flexible and invasive. Evolutionary processes that increase competitive performance might translate in successful range expansions into new environments. A recent niche dynamics quantification framework allows to identify and calculate the different sub-processes of niche shifts, i.e. niche unfilling, niche stability and niche expansion. The present study investigated niche dynamics at a broad biogeographical scale, using comprehensive distribution data of 70 weedy species native to Eurasia and neophytic to North America. By incorporating niche characteristics and relevant plant traits as predictor variables we seek to deepen our understanding of non-indigenous species' niche dynamics by testing the following hypotheses:

1) Successful invasive species are supposed to be flexible and adaptive and should reveal small amounts of niche unfilling combined with high degrees of niche expansion. 2) Because functional traits are among the most important features determining demographic and dispersal processes, we expect a close relationship of certain trait profiles with proportions of niche stability, unfilling and expansion. 3) The degree of niche equilibrium within a species native range should be negatively related to unfilling and expansion and positively related to stability.

Looking at our results we found amounts of niche stability to be very high, while unfilling and expansion occurred quite rarely. The most important predictor variable for the sub-processes of niche dynamic was the native niche volume instead of functional traits. The native equilibrium-situation had no significant impact on the single sub-processes, yet was highly related to niche overlap measured as SDM prediction success.

O11 - The evolution of plant-pollinator specificy in Wettina palm species (Arecaceae) in different environments

Zorayda Restrepo Correa[1], Christine D. Bacon[2,3], Luis A. Nuñez Avellaneda[4], Sebastian González Caro[1], Francisco J. Velásquez Puentes[2,3,5]

[1]Laboratorio de Servicios Ecosistémicos y Cambio Climático, Medellín, CO
[2]University of Gothenburg, Department of Biological and Environmental Sciences, Gothenburg, SE
[3]Laboratorio de Biología Molecular (CINBIN), Department of Biology, Universidad Industrial de Santander, Bucaramanga, CO
[4]Universidad de la Salle, Department of Biology, Bogotá, CO
[5]Technische Universität München, Department of Ecology and Ecosystem Management, Freising, DE, franlucard@gmail.com

In order to understand the driving factors behind the specificity amongst plant pollinators, we characterized species in the beetle genus *Mystrops* from eight palm species of the genus *Wettinia* (Arecaceae). From each of the major clades of the *Wettinia* phylogeny we chose representative species. For these palm species, we collected 31 inflorescences of at least three individuals per species from three different regions of the plant distribution (Choco, Andes, and Amazon). Inflorescences resulted in 60,000 visiting insect individuals collected, 53% of which correspond to 17 different *Mystrops* morpho species. The average number of pollinator species was higher in *W. fascicularis* (five morpho species) and lowest in *W. drudei* (one morpho species). We found high specificity between the *Mystrops* assemblages and species of *Wettinia*, and in general terms, one dominant pollinator species for each *Wettinia* species. These results confirm previous reports of a strong mutualistic relationship between Arecaceae and *Mystrops*. Using inference of environmental niches, we found *Wettinia* species to be segregated along their distribution on climatic gradients. Finally we found that *Mystrops* species turnover was affected by climatic and topographic complexity, but independent on the phylogenetic relatedness of its host palms, which highlights the role of abiotic factors in shaping differences among *Mystrops* pollinator communities.

O12 - Last glacial maximum climate change legacy in island biodiversity

Patrick Weigelt[1], Manuel Steinbauer[2], Juliano Sarmento Cabral[1], Holger Kreft[1]

[1]Biodiversity, Macroecology & Conservation Biogeography Group, University of Göttingen, Göttingen, DE, pweigel@uni-goettingen.de
[2]Section Ecoinformatics & Biodiversity, Department of Bioscience, Aarhus University, Aarhus, DK

Present biogeographical models regard islands either as 1) geologically static with biodiversity resulting from neutral immigration-extinction dynamics or 2) geologically dynamic with changes in area and habitat heterogeneity and biodiversity resulting from immigration-speciation-extinction dynamics over millions of years. Compared to most of the late Quaternary with recurrent and much longer, cooler and drier glacial periods, however, the climate and spatial arrangement of islands observed today is rather exceptional. These shallow-time dynamics act orders of magnitude faster than the relatively slow deep-time geological processes of island formation and erosion considered in biogeographical theory. Recurrent fluctuations in sea level and associated changes in island area, isolation and connectivity thus provide ideal opportunities to assess the effect of shallow-time environmental changes on present biodiversity. Here, we analysed the effects of present and last glacial maximum island area, isolation and climate on angiosperm diversity on islands worldwide (species richness, endemic richness, and proportion of endemic species). We found past island characteristics, especially changes in area, to have strong effects on present number and proportion of endemic species, while species richness was more strongly related to present island characteristics. Specifically, the number and proportion of endemic species was higher on islands that were larger in the recent past. We conclude that, while species richness seems to be closer to equilibrium with present environments, environmental conditions of the last glacial maximum and effects of sea-level changes are essential to understand patterns of island endemism and its underlying evolutionary dynamics. Island biogeographical theory should hence be expanded to accommodate the effects of shallow-time environmental changes on the origin and distribution of endemic species.

O13 - Late Quaternary Environment Reconstruction in Southern Brazil Inferred from Pollen and Organic-walled Dinoflagellate Cysts in Marine Deposits

Fang Gu[1,2], Anastasia Poliakova[1], Hermann Behling[1]

[1]Department of Palynology and Climate Dynamics, Göttingen, DE, Fang Gu@biologie.uni-goettingen.de
[2]China University of Geoscience (Beijing), Beijing, CN, Fang Gu@biologie.uni-goettingen.de

A 700 cm-long marine sediment core GeoB 21073-3, located in the southwestern of Atlantic Ocean off southern Brazil, has been studied by dinoflagellate cysts and pollen grains to reconstruct environmental changes and vegetation during the last glacial and Holocene period. The aim is to understand how changes in the marine realm such as changes in the ocean circulation have changed the vegetation and climate in southern Brazil. Living organic-walled dinoflagellates are greatly influenced by temperature, nutrient concentrations and salinity variations in the water volume and good indicators of the physical water conditions. Pollen from the continent deposited in marine sediments indicates past vegetation changes. The result shows that southern Brazil was markedly influenced by changes in the marine currents according to the dinocysts distribution and pollen distribution. Marked changes in the marine currents had probably a strong influence on the vegetation on the continent.
Keywords: pollen, vegetation, dinoflagellate cysts, climate change, the Atlantic Ocean

O14 - Long-term vegetation, biodiversity and fire dynamics of southern Brazilian ecosystems and its implication for conservation and management

Hermann Behling[1]

[1]Department of Palynology and Climate Dynamics, Göttingen, DE, hbehlin@gwdg.de

Palaeoecological background informationis needed for management and conservation of the highly diverse mosaic of *Araucaria* forest and Campos (grassland) in southern Brazil. Questions on the origin of *Araucaria* forest and grasslands, its development, its biodiversity, dynamic and stability, its response to environmental change such as climate, and the role of human impact, are essential. Further questions on its natural stage of vegetation or its alteration by pre- and post-Columbian anthropogenic activity are also important. To answer these questions, palaeoecological and palaeoenvironmental data based on pollen, charcoal, and multivariate data analysis of radiocarbon dated sedimentary archives from southern Brazil are used to provide an insight into past vegetation changes that allow us to improve our understanding of the modern vegetation and to develop conservation and management strategies for the strongly affected ecosystems in southern Brazil.

O15 - Testing the information content of phylogenetic dispersion for inferring community assembly mechanisms

Florian Hartig[1], Paul Bauche[1]

[1]University of Freiburg, Freiburg, DE, florian.hartig@biom.uni-freiburg.de

A commonly applied assumption in the analysis of community data is that phylogenetic dispersion can be used to infer the processes dominating community assembly. Phylogenetic clustering is viewed as evidence for habitat filtering, and phylogenetic overdispersion as evidence for competition-driven assembly. We test these assumptions using a spatially explicit, individual-based simulation of a biogeographic region, in which species distributions and local communities originate from the processes of speciation, climatic niche evolution, evolution of competition traits, and dispersal. We show that phylogenetic signal is indeed influenced by the assembly processes, but because community assembly and dispersal affect phylogenetic dispersion in a rather complicated way, one can only reliably infer the assembly processes if the historical dispersal limitation is known. We conclude that there is a considerable danger to misinterpret phylogenetic signal originating from dispersal processes as evidence for particular community assembly mechanisms.

O16 - The role of hoverfly - plant species interaction in maintenance of pea aphid host races

Ilka Vosteen[1], Jonathan Gershenzon[1], Grit Kunert[1]

[1]Max Planck Institute for Chemical Ecology, Jena, DE, ivosteen@ice.mpg.de

Herbivorous insects are the most diverse group of multicellular organisms inhabiting our world. One process that may have contributed to this enormous biodiversity is ecological speciation via continuous host plant switches. We use the pea aphid (*Acyrthosiphon pisum*) complex as a model system to study this process. The pea aphid complex consist of at least 11 genetically distinct host races which are native to specific host plants of the Legume family, but can all develop on the universal host plant *Vicia faba*. The factors that gave rise to and maintain these host races are not yet known, but natural enemies might support it. If they would prefer certain plants for prey searching or oviposition, aphids might favour or have a higher fitness on other (enemy free) plants, which would help to maintain the different pea aphid host races.

We tested for the existence of enemy free space by exposing three pea aphid host races feeding either on their respective native host plants, *Medicago sativa*, *Trifolium pratense*, or *Pisum sativum*, or on the universal host plant to natural predator populations in the field. We found a strong oviposition preference of hoverflies (*Episyrphus balteatus*) for two aphid host races feeding on the universal host plant *V. faba*. Since hoverfly larvae are important aphid predators we conclude that they may force these two pea aphid host races to use other host plants than *V. faba*.

Hoverflies oviposition preference corresponded with aphid performance, well performing aphids experienced more hoverfly eggs on their host plants. This might be due to the differences in aphid's honeydew production, since we could show that honeydew is an important oviposition cue for hoverflies. Accordingly, aphids feeding on less-suitable host plants, where they showed a reduced performance and honeydew production, experienced less hoverfly eggs on their plants. Thus less-suitable host plants might create an enemy-free space that has the potential to compensate the aphid's performance disadvantages on inferior plants. This mechanism probably plays an important role in aphid host race formation processes.

O17 - Assembling a meadow from a tree: close relatives repulse each other in some but attract each other in other lineages

Alex Fergus[2], Eric Allen[3], Tania Jenkins[3], Jana Petermann[2], Christiane Röscher[4], Bernhard Schmid[2], Andreas Prinzing[1]

[1]Univ. Rennes 1 / CNRS, Rennes, FR, andreas.prinzing@univ-rennes1.fr
[2]Institute of Evolutionary Biology and Environmental Studies, University of Zürich,, CH-8057 Zürich, CH
[3]Institute of Ecology, Friedrich Schiller University of Jena, Jena,, DE
[4]Max-Planck-Institut für Biogeochemie, Jena, DE

Simple models of community assembly suggest that competitive exclusion is more likely among closely related species. However, recent concepts suggest that competitive exclusion might be less likely, and facilitation more important, among close relatives. It remains unknown whether there is a balance between such repulsion and attraction of close relatives and what it depends on. We studied natural reassembly of experimental grassland communities [give some words of details]. We found that through re-assembly average phylogenetic distance of species increased but the average distance among most closely related species decreased, and coexistence became uncorrelated to relatedness. This was observed even when aiding colonization by seed addition and hence likely reflected local niche-based processes rather than regional dispersal-related processes. Related species increasingly coexisted among reassembling Fabaceae and Pooaceae, and decreasingly coexisted among Asteraceae (no change among Apiaceae). These shifts could both be weakened (Poaceae) or strengthened (Apiaceae) by suppression of dispersal limitation under seed addition. Repulsion and attraction of phylogenetically closely related species hence exist both and they exist in parallel. Repulsion and attraction dominate in different lineages, suggesting that recent evolutionary diversifications may be maintained between local communities in repulsion lineages, but within communities in attraction lineages.

P1 - The efforts in mapping China's biodiversity

Keping Ma[1], Zheping Xu, Bin Chen, Haining Qin and Cui Jinzhong

[1]Institute of Botany, Chinese Academy of Sciences, Beijing, CN

Mapping biodiversity is one of the key steps for biodiversity planning, conservation and research. Distribution data are scattered in different kind of sources such as specimens, literatures, observatories and so on. After the efforts of 6 decades, Flora of China(Chinese version) was completed with 80 volumes and 126 books in 2004, Flora of China(second version in English) was completed with 50 volumes in 2013, more than 140 volumes of Fauna of China(Chinese version) and 95 volumes of Flora Sporophytae Sinicae have been published so far. The first version of Catalogue of Life-China was formally released in 2008 and since then it was updated every year with fully free access by both CD and a website (http://www.sp2000.cn/joaen/). There are 79792 taxa (69920 species & 9872infraspecific taxa) in 2014 Annual Checklist of Catalogue of Life-China, including higher plants, vertabrates, spiders andsomeother invertebrates, some taxa of micobes. From early 2000s, we began digitizing specimens of plants, enimals and fungi. Up to now, 7 millions of plant specimens, 3 millions of animal specimens and a half million of fungi specimens have been digitized. A number of websites sharing such kind of data were established. National Specimen Information Infrastructure with 10.6 millions of digitized specimens (NSII, http://www.nsii.org.cn/) is the master website among them. Associated websites are as follows, Chinese Virtual Herbarium with 3.4 millions of digitized plant specimens (CVH, http://www.cvh. org. cn/), Chinese Field Museum with 5.6 millions of observations (color photos)(CFH, http://www.cfh.ac.cn/), Animal Specimen Information Sharing Platform with 2.9 millions of difitized specimens (http://www.nzmc.org/) and Biodiversity Heritage Library-China with 1.8 K digitized books associated with flora and fauna in China (BHL-China, http://www.bhl-china.org/bhl/). The on-line data sources are the baseline infrastructure for the initiatves in mapping biodiversity in China.

P2 - Latitudinal differences in species abundance distributions, rather than spatial aggregation, explain beta-diversity along latitudinal gradients

Wubing Xu[1,2], Guoke Chen[1], Canran Liu[3], Keping Ma[1]

[1]State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences, Beijing, CN, xuwubing@ibcas.ac.cn
[2]University of Chinese Academy of Sciences, , Beijing, CN, xuwubing@ibcas.ac.cn
[3]Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Victoria, AU

Background/Question
Variation in species composition among sites (β-diversity) generally decreases with increasing latitude, but the underlying mechanisms are ambiguous. Although both local and large-scale processes may drive this pattern, they act all through influencing the species abundance distribution (SAD) and spatial pattern of species. A null model incorporating SAD is often used to calculate expected β-diversity, which accounts for most variation in β-diversity. However, a recent study has shown that the deviation of observed β-diversity from expected values (β-deviation) increases with latitude. The latitudinal gradients in β-deviation may be related to both latitudinal differences in SADs and the degrees of spatial aggregation. Our study aims to (1) investigate how β-deviation varies with SAD and spatial aggregation, and (2)

separate the contributions of SAD and aggregation in explaining latitudinal gradients in β-deviation.

Methods
A total of 197 forest plots (each containing 10 subplots) distributed along latitudinal gradients were used. Based on the occupancy abundance relationship, we derived two β-diversity models, which could calculate the β-diversity for random and nonrandom communities. The two models were used to simulate relationships of β-deviation with SAD and aggregation, and to separate the contributions of these two factors in explaining latitudinal gradients in β-deviation.

Results/Discussion
The β-deviation increased with the degree of aggregation and peaked at intermediate species abundance. The fraction of β-deviation linked to SAD increased with latitude in global and regional analyses, whereas the fraction of β-deviation linked to aggregation was only significantly correlated with latitude in New World south. The degree of aggregation increased with latitude in New World south, but not in global extent and New World north. The latitudinal gradients in β-deviation are primarily explained by latitudinal differences in SADs. Additionally, the expected β-diversity is determined solely by SAD. Therefore, we conclude that latitude-β-diversity gradients at local spatial scales appear to be explained by latitudinal differences in SADs.The factors that cause latitudinal differences in SADs are likely the drivers of latitudinal patterns of β-diversity.

P3 - Aquatic macroinvertebrate communities in bromeliads along elevation gradients in Costa Rica

Marcia A. Adler Yanez[1], Annika Busse[2,3], Jana S. Petermann[2,3]

[1]Georg-August-Universität, Göttingen, DE, m.adleryanez@stud.uni-goettingen.de
[2]Freie Universität, Berlin, DE
[3]Universität Salzburg, Salzburg, AT

Elevation gradients have shown to have a big impact in species richness and community's composition in many different species. Although studies have been done on elevational gradients, it isn't clear yet which factors influence the most these differences in species richness. Aquatic communities that live in the water accumulated between the bromeliads leafs (phytotelmata) are composed mostly of insect larvae and other small invertebrates. These communities are good model systems since given their relatively small size they are easy to study and it is totality (it is possible to have an exact count of the inhabiting individuals). With this study we aim to get a better understanding of the factors that structure communities in tropical ecosystems and specifically how altitude affects community patterns.

We conducted a survey in Costa Rica during the wet season 2014 (May-August) to study the aquatic macroinvertebrate communities' composition in bromeliads along elevational gradients. We measured abiotic variables of the phytotelmata water such as pH, dissolved oxygen concentrations, temperature, bromeliad size and dry weight of death organic matter fallen into the phytotelmata, as well as other environmental factors such as air temperature and light availability. Then, we extracted the inhabiting communities and identified and counted all insect larvae. Furthermore, a colonization experiment was conducted in which artificial bromeliads were placed in different altitudes and collected at different points in time to investigate colonization dynamics.

Preliminary data show that there is no a significant pattern in the macroinvertebrate communities along the elevational gradient. However, species composition changes. Understanding the relationship of these factors we may also be able to have a better underfunding of these communities and so be able to protect them more efficiently.

P4 - Testing the thermal melanism hypothesis with Western Palearctic moths

Lea Heidrich[1], Roland Brandl[1], Dirk Zeuss[1]

[1]Philipps-University of Marburg, Faculty of Biology, Department of Ecology, Animal Ecology, Marburg, DE, lea.heidrich@gmx.de

The Thermal Melanism Hypothesis (TMH) states that dark-coloured ectotherms heat up faster than light-coloured ectotherms due to higher absorption of solar energy by melanin. Therefore, dark-coloured diurnal ectotherms should have an advantage in cold conditions and hence melanization should increase towards higher latitudes or elevations. A spatial pattern consistent with the TMH has been found in several intra- and interspezific studies on insects. However, melanization is a complex trait that is also influenced by other factors (e.g. predation, sexual selection) and spatial patterns of melanization could also result from abiotic or biotic drivers with a spatial structure closely correlated to temperature.

In an attempt to search for alternative explanations, we analysed the colour lightness of nocturnal moths. In contrast to diurnal insects, nocturnal insects should show no gradient because they are not directly affected by radiation during their main activity time. To test for the direct effect of solar radiation, we used the colour lightness value gained from image analyses of diurnal and nocturnal geometrids. Our index of colour lightness ranged for 0 (black) to 1 (white). Furthermore, we compiled data on the distribution of 612 geometrids (168 nocturnal, 39 diurnal) covering 4360 grid cells of 50 km × 50 km across the Western Palearctic.

Ordinary linear models showed a strong positive correlation between solar radiation and mean colour lightness – both for diurnal and nocturnal assemblages of geometrids (all: $r^2 = 0.61$, $p < 0.001$; nocturnal: $r^2 = 0.53$, $p < 0.001$; diurnal: $r^2 = 0.35$, $p < 0.001$). This strong gradient in the colour lightness of nocturnal geometrids hints to the possibility that the increased occurrence of dark coloured species in northern latitudes might also be due to factors e.g. body size or camouflage which covary with temperature and solar radiation.

P5 - Regional variation in the phylogenetic structure of European dragonfly assemblages

Stefan Pinkert[1]

[1]Department of Ecology, Animal Ecology, Philipps-University Marburg, Marburg, DE, StefanPinkert@posteo.de

Assessments of the determinants of large-scale variation in biodiversity have commonly focused on spatial patterns in species richness. However, because this approach assigns equal value to each species most current explanations of patterns in biodiversity suffer from not considering differences in the phylogenetic structure of communities that may underlie the present-day distribution of species. Recent studies suggest that while phylogenetic diversity and species richness are closely related, residuals of this relationship can yield insights into the historical processes of community assembly. We constructed a phylogeny based on currently available literature and sequence data, including 115 of in total 133 European dragon- and damselfly species, and combined it with distribution maps from the IUCN Red List Assessment (2009; 2010) projected onto an equal area grid (50 km x 50 km) to map the residuals from regressions between Faith's phylogenetic diversity index (FPD) and species richness. The variation in FPD was highest correlated with species richness (r^2=0.94) and the residuals of this relation showed a clear spatial pattern. Assemblages with negative residuals are located throughout northern and north-eastern Europe. In this area most co-occurring species are representatives of closely related lineages of Asian origin (e.g. *Aeshna, Leucorrhinia*). In contrast, positive residuals are found across southern Europe and Great Britain, where the ranges of Asian lineages and the ranges of some isolated African lineages (e.g. *Trithemis, Zygonyx*), overlap. Our analysis supports the long-standing hypothesis that only a closely related subset of species possessed the adaptations to (re-)colonize northern Europe after the glaciers had retreated. These findings demonstrate clearly that historical dispersal routes and adaptations as expressed by evolutionary history have left a detectable phylogenetic signal in the contemporary structure of European dragonfly assemblages.

P6 - Assessing peculiarities of island floras: A global analysis of taxonomic and functional disharmony in vascular plants

Christian König[1], Patrick Weigelt[1], Holger Kreft[1]

[1]Biodiversity, Macroecology & Conservation Biogeography Group, University of Göttingen, Göttingen, DE, Christian.Koenig@forst.uni-goettingen.de

Disharmony describes the compositional imbalance of island biota compared to mainland source regions. It may arise from taxon-specific differences in the ability to disperse to and to survive and diversify on islands and thus involves key biogeographical processes. Here, we present a global quantitative analysis of island disharmony, based on vascular plant floras of 315 islands and 43 mainland units. Species were assigned to a consistent taxonomy and supplemented with information on growth form (tree, shrub, herb), woodiness and epiphytism from literature resources. We quantified taxonomic and functional disharmony by calculating the mean Bray-Curtis dissimilarity between the relative family and trait level proportions of an island and 100 samples randomly drawn from the most probable mainland source regions in the dataset. Islands were more variable in their compositional structure than mainlands and showed an overrepresentation of ferns and epiphytes. Isolation, island size and bioclimatic conditions had significant effects on functional and taxonomic disharmony, highlighting the crucial roles of dispersal abilities and ecological constraints for global species distributions.

P7 - Drivers of plant invasions: a global assessment of traits promoting plant naturalization.

Bernd Lenzner[1], Wayne Dawson[2], Stefan Dullinger[1], Franz Essl[1], Mark van Kleunen[2], Dietmar Moser[1], Jan Pergl[3], Petr Pyšek[3,4], Hanno Seebens[5], Marten Winter[6]

[1]Division of Conservation, Vegetation and Landscape Ecology, University Vienna, Vienna, AT, bernd_lenzner@gmx.de
[2]Department of Biology, University of Konstanz, Konstanz, DE
[3]Institute of Botany, Department of Invasion Ecology, Czech Academy of Sciences, Průhonice, CZ
[4]Department of Ecology, Faculty of Science, Charles University in Prague, Prague, CZ
[5]Institute for Chemistry and Biology of the Marine Environment, University of Oldenburg, Oldenburg, DE
[6]German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig, DE

Biological invasions have become one of the major features of on-going biodiversity change. However, despite intensive research, there is a paucity of robust global data sets of alien species distributions for most taxonomic groups. Consequently, we have a lack of understanding of the patterns and processes of the global exchange of alien species. However, based on a large collaborative effort, the Global Naturalized Alien Flora (GloNAF) database has recently been finalized. GloNAF is the first truly global dataset on naturalized plant species distributions in >800 terrestrial regions (countries, sub-national regions such as islands, federal states, provinces) covering >90% of the Earth’s land area. In total, c. 13 000 plant species contribute to the pool of naturalized species worldwide. Europe has accumulated the largest number of alien species and temperate Asia is the major donor of naturalized species. In addition, GloNAF provides a wide range of opportunities to quantify macroecological and phylogenetic patterns to explore the main drivers of plant invasions, and in our talk we will highlight some of these. In particular, we are going to present how interlinking naturalized species records with morphological trait data enables us to explore which traits increase the invasiveness of individual species and why some families are overrepresented among the global set of naturalized species.

P8 - Ecological niches and geographic distributions: Quantifying the Hutchinsonian niche from range-wide variation in demographic rates

Jörn Pagel[1], Martina Treurnicht[1,2], Henning Nottebrock[1], Karen J. Esler[2], Frank Schurr[1]

[1]University of Hohenheim, Stuttgart, DE, jpagel@uni-hohenheim.de
[2]Stellenbosch University, Stellenbosch, ZA

The ecological niche concept is central for the understanding of many aspects of biodiversity dynamics. In particular the study of geographic ranges largely relies on correlative species distribution models that search for statistical relationships between species' occurrence and environmental covariates. However, dynamic processes(source-sink dynamics, migration limitation, time-delayed extinction) can cause mismatches between the geographic distribution of a species and Hutchinson's realized niche. A clarification of the link between species' ecological niches and their geographic distribution thus requires understanding how large-scale range dynamics arise from variation in demographic processes across environmental gradients.

In this study we investigate demographic variation of serotinous shrubs (Proteaceae) in the Cape Floristic Region, South African. For the quantification of species' niches we assembled3,454 population-level records of key demographic rates (fecundity, per-capita recruitment rate and adult survival) across the global geographical ranges of 26 species. We use an hierarchical Bayesian modelling approach to integrate the sampled data for estimating thespecies-specificresponses of demographic rates to environmental covariates. The demographic analysis does not only consider effects of climatic and edaphic conditions but also of variable fire return intervals and density dependence at both the adult and the seedling stage. From the estimated demographic response functions we can then predict variation of long-term annual intrinsic population growth rate in in response to multiple environmental drivers and thereby quantify Hutchinsonian niches as the set of suitable environments in which intrinsic population growth rate is positive. However, mismatches between projections of the estimated niches into geographical space and the species' actual geographic distributions suggest that additional processes (migration limitation, variable biotic interactions) limit their geographic distributions.

P9 - Integrating population, species, community and biogeographical patterns: the Ecology, Evolution and Environmental Integrative Model

Juliano Sarmento Cabral[1], Kerstin Wiegand[2], Holger Kreft[1]

[1]Biodiversity, Macroecology & Conservation Biogeography, University of Göttingen, Göttingen, DE, jsarmen@uni-goettingen.de
[2]Ecosystem Modeling, University of Göttingen, Göttingen, DE

How diversity emerges and varies over space and time is the holy grail of ecology. Whereas correlative approaches are insightful, they cannot prove causality and thus the understanding of biodiversity dynamics requires a mechanistic approach assessing underlying processes. We present a simulationmodel that combines ecological, evolutionary and environmental processes under pattern-oriented framework investigating biodiversity patterns. The model is stochastic, grid-based and integrates ecological processes at the population level (i.e. metabolic, demographic and interaction constraints) with evolutionary (mutation and speciation) and environmental (geo-climatic dynamics) processes. We used terrestrial plants and oceanic islands as study system.We ran the full model to assess emerging patternsacross spatiotemporal scales and organization levels (i.e. populations, species, communities and assemblages). Thereafter, we switched off processes, hypothesizing that: 1) environmental dynamics and speciation are necessary for biogeographical patterns to follow theoretical predictions; 2) competition is necessary to regulate richness and speciation patterns; 3) metabolic constraints are necessary for realistic population dynamics and communities. The full scenario generated multiple patterns generally matching empirical and theoretical expectations. For example, populations were largest at young, species-poor islands. Species, particularly endemics, could better fill their potential range at small, species-poor islands. Richness gradients followed mid-domain effects, but proportion of endemics was highest at old, large and isolated habitats. Species and trait richness were unimodal over time. Switching off processes affected these patterns, supporting our hypotheses. Integrating ecological, evolutionary and environmental processes seem essential to simultaneously generate realistic population, species, community and assemblage level patterns over space and time.

P10 - A 20-million-year relationship between fossil mammalian diversity and primary productivity - and how humans have dissolved it

Susanne Fritz[1,2], Jussi Eronen[1,3], Jan Schnitzler[1,2], Christian Hof[1], Christine Janis[4], Andreas Mulch[1,2], Katrin Böhning-Gaese[1,2], Catherine Graham[1,2,5]

[1]Senckenberg Biodiversity and Climate Research Centre (BiK-F), Frankfurt, DE, sfritz@senckenberg.de
[2]Goethe University, Frankfurt, DE, sfritz@senckenberg.de
[3]University of Helsinki, Helsinki, FI
[4]Brown University, Providence, Rhode Island, US
[5]Stony Brook University, New York, US

Spatial diversity patterns of extant animals are correlated with primary productivity today. We provide evidence for a strong relationship between fossil diversity of large mammals and terrestrial net primary production that has been consistent in the Northern Hemisphere through the Neogene (23-1.8 million years ago). Our analyses combine estimates of terrestrial net primary production derived from paleobotanical databases with the largest intercontinental fossil dataset of terrestrial large mammals, spanning >14,000 presence-absence records of 690 genera in five orders through the Neogene. However, the fossil spatio-temporal diversity-productivity relationship breaks down in the present day because the combination of human impacts and Pleistocene climatic fluctuations has strongly affected the primary productivity available to natural systems, and has driven many mammalian species into decline or to extinction. Our study demonstrates the striking anthropogenic effects on general ecological patterns, stressing the need for integrative analyses of ecological relationships across fossil and extant species.

P11 - Long term vegetation-climate interaction in coastal savanna of northern South America?

Kamaleddin Alizadeh[1], Paula Rodriguez[1], Marcondes Lima da Costa[2], Marcelo Cohen[2], Hermann Behling[1]

[1]Georg-August-Universität Göttingen, Göttingen, DE, kamal.alizadeh@biologie.uni-goettingen.de
[2]Universidade Federal do Pará, Belém, BR

The occurrence of a 2,000 km-long costal savanna belt from British Guiana to northern Brazil where climate is suitable for rainforest formation is controversial. To discover the potential cause of this savanna belt, we carried out pollen and charcoal analysis on two sediment cores from Amapá State coastal savanna belt. The first is 750 cm-long, 11,500 years old core from a small swamp near Macapa' city and the second is 81 cm-long, 4,000 years old core from a small gallery forest with *Mauritia*, about 100 km north of the first site. Our results reveal that beside specific arboreal vegetation, savanna was present in the area at least since 11,500 cal yr BP which later (11,200 cal yr BP) expanded due to drier climatic conditions. The early Holocene Atlantic sea rise facilitated the formation of mangrove, swamp forest and later *Mauritia* swamps in the site one. During the mid-Holocene (8,500-5,500 cal yr BP) gallery forest expanded into the savanna reflecting higher precipitation rates. During the late Holocene (after 5,500 cal yr BP), area of gallery forest shrank and showed some oscillation and conversely *Mauritia* swamp expanded. We suggest that the dry early Holocene is attributed to northern most position of Inter Tropical Convergence Zone (ITCZ) which during the Holocene migrated southward and merged with South Atlantic convergence zone (SACZ) and cause moister condition during the mid-Holocene. Unstable late Holocene is ascribed to the intensified ENSO which prevents SACZ to reach the Northern South America. In summary, because of the specific geomorphology, the area was occupied by forest/gallery forest only during the mid-Holocene when probably annual rainfall was higher than today. Also high charcoal concentration throughout the record together with long history of human settlements in Amazonia, strengthen the suggestion that natural/anthropogenic fire plays also an important role to stabilize the savanna.

P12 - Comparison between long-term south-eastern Amazonian upland and lowland rainforest dynamics during the Holocene

Kamaleddin Alizadeh[1], Marcelo Cohen[2], Marcondes Lima da Costa[2], Hermann Behling[1]

[1]Georg-August-Universität Göttingen, Göttingen, DE, kamal.alizadeh@biologie.uni-goettingen.de
[2]Universidade Federal do Pará, Belém, BR

Palynological studies in the Carajás region have already indicated a marked vegetation change by the increase of forest and decrease of the savannah area. This change is attributed to onset of wetter climatic condition during the last four millennia due to the southward shift of intertropical convergence zone. To understand long-term ecosystem dynamics and ecological response to environmental changes in detail, two sediment cores, one from upland (BRT) in Carajas, one from lowland (MRB) near Marabá in south-eastern Amazonia were studied and compared by pollen, charcoal and lithological analysis. First results from the BRT record, which is at least 4500 years old, indicate that a relatively stable very diverse rainforest was dominant in the study area which may reflect the response of arboreal vegetation to the wetter condition. However, area of herbs and palms gradually increased and shrubs and wetland trees became less frequent throughout the record. This decrease in shrubs and wetland trees under the wetter condition of late Holocene may indicate anthropogenic influence on the adjacent scrubland. These results will be compared with the MRB core to understand in detail Holocene vegetation, fire and climate dynamics of Amazonian upland and lowland rainforest.

P13 - Mid-Holocene vegetation changes in northwestern Amazonia inferred from Serra do Tepequém, the Brazilian Tepuis in Roraima State

Paula A. Rodríguez-Zorro[1], Marcondes Lima da Costa[2], Hermann Behling[1]

[1]Department of Palynology and Climate Dynamics, Albrecht-von-Haller Institute for Plant Sciences, Georg August University Göttingen, Göttingen, DE, paula.rodriguez@biologie.uni-goettingen.de
[2]Departamento de Geoquímica e Petrologia, Centro de Geociências,Universidade Federal do Pará, Pará, BR

Serra do Tepequém is a plateau (1000 m.a.s.l) located at the Brazilian Guyana and its vegetation is mostly represented by a mosaic of Amazon rainforest and savanna. In Roraima State, palaeoecological records show wetter conditions for the late Holocene with dominance of *Mauritia flexuosa* and gallery forests, but there are no studies that report the beginning of those humid conditions in the region. Savanna vegetation changes related to the increase of wetter conditions have been reported since ca. 6000 yr BP and 3600 yr BP in the Colombian savannas. Such changes were detected by the increase of gallery forest, palms and the contraction of savanna vegetation. As a first palaeoecological approach into the last 7000 yr BP vegetation dynamics in the Roraima state savannas, we used a multi-proxy analysis to detect vegetation and environmental changes applying pollen, loss on Ignition and micro-charcoal analyses on a radiocarbon dated sediment core.

Our first results show a reduction of the savanna and the increase of the *Mauritia flexuosa* palm and other forest taxa indicating changes from drier to wetter conditions through the mid-Holocene in the area. The first period from ca. 7000 cal yr BP to 6000 cal yr BP displays a dry phase by the presence of grassy savannas, dominated by Cyperaceae and Poaceae vegetation. Low pollen concentration and high peaks of charcoal particles are associated to a dry period in which savanna was expanded. The second period between ca. 6000 cal yr BP and 4500 yr BP shows an increase on wetter conditions due to the rise of *Mauritia flexuosa,* palms, and forest taxa as well as the reduction on the savanna taxa and charred particles.

P14 - Late Holocene environment and land use dynamics in the estuarine Segara Anakan Lagoon, Java, Indonesia

Kartika A Hapsari[1*]; Tim C Jennerjahn[2]; Hermann Behling[1]

[1] Dept. of Palynology and Climate Dynamics, Univ. Goettingen; [2] Dept. of Biogeochemistry and Geology, Leibniz Center for Tropical Marine Ecology (ZMT) Bremen

Kartika.Hapsari@biologie.uni-goettingen.de

In the past decades, in line with the development of society, the number and intensity of threads to coastal areas are growing. As one of the most dynamic yet vulnerable ecosystem, coastal lagoon needs to be protected due to its valuable functions. In southern Java the Segara Anakan Lagoon is one of an example of intense sea-land interaction influence. It is facing rapid degradation due to continuous modification and natural source exploitation. High sedimentation rates and mangrove logging are the major threats to the system. There is lack of information how land use change and resource exploitation alter the functions of the lagoon, especially during the Anthropocene. Therefore, the further studies of past dynamics of the lagoon become necessary. With this study we provide insights into the dynamics of Segara Anakan Lagoon, by studying a 470 cm-long sediment archive. The varying terrestrial and marine input will be reconstructed applying a multi-proxy approach using pollen, spores, XRF-scanning and AMS radiocarbon dating. The information recorded in the sediment will provide eg. past vegetation dynamcis in the surrounding of the lagoon, natural events as well as signal of anthropogenic activities,. Our results lead to a better understanding of long-term ecological processes and anthropological impacts. This helps to develop coastal management plans, as well as preventing actions needed in the future.

P15 - 25,000 years of vegetation dynamics in the savanna of south-eastern Kenya: the pollen record from Lake Challa near Mt. Kilimanjaro

Lisa Schüler-Goldbach[1,2], Stephen M. Rucina[4], Vanessa Gelorini[5], Rob Marchant[6], Andreas Hemp[2], Dirk Verschuren[3]

[1]Department of Palynology and Climate Dynamics, Göttingen University, Göttingen, DE, lschuel@gwdg.de
[2]Department of Plant Systematics, Bayreuth University, Bayreuth, DE, lschuel@gwdg.de
[3]Department of Biology, Ghent University, Ghent, BE
[4]National Museum of Kenya, Nairobi, KE
[5]Department of Geology and Soil Science, Ghent University, Ghent, BE
[6]Environment Department, University of York, York, UK

Late Quaternary sediments recovered from Lake Challa, a steep-sided crater lake situated at 840 m asl southeast of Mt. Kilimanjaro, present a uniquely continuous record of vegetation dynamics in the lowland savannas of eastern equatorial Africa since the Last Glacial Maximum (LGM). Today the Challa crater basin is surrounded by a landscape of mostly open bush and grass savanna with scattered woodland trees and shrubs, and strips of riverine forest along seasonally dry streams.

Pollen taxa representing savanna vegetation were abundant throughout the past 25 ka. During the LGM and the early deglaciation period until about 17 ka BP, the grass savanna landscape was characterized by abundant Asteraceae and *Euphorbia*. After 17 ka BP there is a marked decline in Asteraceae. Taxa of the alpine *Ericaceae* belt are most abundant during the LGM, suggesting that this vegetation type shifted down-slope during the cold climate conditions which prevailed at higher altitudes. Montane forest taxa have been present since the LGM but especially the montane forest trees *Olea, Podocarpus*, *Juniperus* and*Syzygium* were most prominent after the LGM, during the locally dry early deglaciation period. These results indicate not only that today's montane forest taxa persisted in the East African mountain ranges during glacial time, but also that grass pollen influx from lowland savanna was reduced. Around 16 ka BP, pollen taxa from dry savannah forest start expanding, consistent with the enhanced precipitation and warming conditions indicated by independent climate proxies. The Late Holocene is characterized by the further evolution of the dry savannah forest community dominated by *Euphorbia* and *Acalypha* with a diverse understory. The gradual decrease in pollen from montane forest taxa throughout the Holocene likely represents the retreat of montane forest to higher elevations and their replacement by more drought-tolerant taxa at lower elevations. The percent abundances of Cyperaceae pollen show a generally inverse relationship with climatic moisture balance over the past 25 ka, but to what

extent this pollen derives from dryland sedges in the immediate vicinity of Challa crater, or wetland sedges from the shallow Lake Jipe basin further away, cannot be ascertained at this time.

END OF SESSION 33

Session 35 - Citizen Science in Ecology - successful scientific case studies from Europe

Short title: Citizen Science in Ecology

CHAIRS: FLORIAN HEIGL, ALETTA BONN, JOHANN G. ZALLER

O1 - Citicen Science and Ecology in Europe and beyond

Josef Settele[1]

[1]UFZ, Halle, DE, Josef.Settele@ufz.de

The key note will give a subjective overview on citizen science activities in Europe and other continents which lead to relevant outputs for ecology in science as well as sustainable development. There will be a certain bias towards studies in which the author was and/or is involved.

O2 - Can opportunistic occurrence records improve the large-scale estimation of abundance trends?

Jörn Pagel[1], Barbara J. Anderson[2], Robert B. O'Hara[3], Wolfgang Cramer[4], Richard Fox[5], Florian Jeltsch[1], David B. Roy[7], Chris D. Thomas[8], Frank M. Schurr[1]

[1]University of Hohenheim, Stuttgart, DE, jpagel@uni-hohenheim.de
[2]Landcare Research, Dunedin, NZ
[3]Biodiversity and Climate Change Research Centre (BIK-F), Frankfurt am Main, DE
[4]Institut Méditerranéen de Biodiversité et d'Ecologie Marine et Continentale (IMBE), Aix-en-Provence, FR
[5]Butterfly Conservation, Manor Yard, UK
[6]University of Potsdam, Potsdam, DE
[7]NERC Centre for Ecology & Hydrology, Wallingford, UK
[8]University of York, York, UK

Data on spatio-temporal variation and trends in population abundance form a cornerstone of biogeography and also an important criterion for the assessment of a species' conservation status. Citizen-science projects can be a valuable data source, where in particular opportunistic occurrence records are collected in high numbers and across large geographic areas. While the interpretation of these data is usually handicapped by inhomogeneous sampling effort, they can still have the potential to inform about abundance variation, in particular when combined with data from more systematic surveys.

A particularly well suited approach for the integration of data from multiple sources is provided by hierarchical Bayesian modelling techniques. We present a model framework that links annual population densities on a spatial grid to both long-term count data and to opportunistic occurrence records as they result from citizen science programs. Specific observation models for both data types accommodate uncertainties at all stages of the link between observational data and the modelled abundance and account for differences in the structure and quality of data from various sources.

In a case study we combined opportunistic occurrence records from the British Butterflies for the New Millennium (BNM) project with systematic transect counts from the Butterfly Monitoring Scheme (UKBMS) for the estimation of long-term abundance dynamics across the range of the Gatekeeper (*Pyronia tithonus*) in Great Britain. The application of the hierarchical observation model facilitates the estimation of variation in abundances across space and time and thereby improves our ability to detect, partly opposing, regional trends in different parts of the butterfly's range. These spatially comprehensive estimates of abundance dynamics from citizen science data have not only implications for conservation monitoring but can also enhance the empirical basis for basic ecological and biogeographic research.

O3 - Species distribution models based on Citizen Science Data for forest conservation planning

Swantje Löbel[1,2]

[1]Swedish Species Information Centre, SLU, Uppsala, SE, swantje.lobel@slu.se
[2]Environmental System Analysis, Inst. of Geoecology, TU Braunschweig, Braunschweig, DE, swantje.lobel@slu.se

Identifying sustainable forest management strategies requires robust predictions of species distributional changes as a consequence of land use and climate change. Our research aims to develop models based on readily-available Citizen Science Data (CSD, obtained from the Swedish Life Watch project, www.svenska-lifewatch.se) that deliver robust information on future population and biodiversity trends in forest landscapes. Assessing species trends under national scenarios of alternative future forestry policies in Sweden will be then possible for a large number of species in a rather cost-effective way. This will substantially improve the scientific basis for forest conservation planning.

The shortage of dead wood in Swedish forests constitutes a major threat to biodiversity. My own focus is on dead-wood inhabiting bryophytes, whereas my colleagues do work with polypore fungi, lichens and birds. Currently, we evaluate different species distribution modelling approaches, including methods that account for sampling bias. Approaches range from popular MaxEnt models, classical GLMs, Bayesian state-space models to a recently published method (Fithian *et al.* 2014), pooling presence-only and presence-absence data for multiple species. Critical is, that covariates affecting the species process are often correlated with those affecting the observation process. A key question is whether projections of future species trends differ among forestry scenarios depending on the type of model applied.

O4 - A beer as starting point for a new flora of the canton of Zurich, Switzerland

Thomas Wohlgemuth[1], Corina Del Fabbro[2]

[1]Swiss Federal Research Institute WSL, Birmensdorf, CH, thomas.wohlgemuth@wsl.ch
[2]Institut für Systematische Botanik, Univ. Zürich, Zürich, CH

In the year 1839, a young medical student wrote the first flor of the canton of Zurich, in which he listed 1140 plant species for an area of 1740 km^2, including localities and abundances. Sixty years later, several botany professors founded the botanical society of Zurich in order to compile a second flora – and greatly failed, though left an unpublished manuscript of 1200 pages containing thousands of findings regarding 1800 species. In 2010, members of the same botanical society initiated – after a few beers – the citizen science project 'FloZ – Flora of the canton Zurich', which aims at recording the current state of the flora in the canton as a sample of 210 1-km^2 squares and detecting changes in species distribution and abundance since 1839. The ongoing project profits from experience of many volunteers, be it third money acquisition, botanical expertise, close-up photography or project management. Thanks to a generous grant from the cantonal lottery fund, a project leader could be employed in 2013, who sustains a headquarter and cares for the most urgent tasks. Important cornerstones are the continuous motivation, a strict time management, the use of modern tools and repeated invitations to 'calibration' events such as mapping camps and key-out evenings. More than 100 botanists are involved up to date, and species lists from 80% of the quadrats are already at hand. Several expert working groups survey the mapping quality, organize the data compilation for historical flora comparisons, design the products such as webpage and books, and analyze the new data. Within the first three years 50'000 data records regarding quadrat abundance of vascular plants have been collected. We conclude that citizen science needs a sound organization and a continuously supported network to keep the motivation of the volunteers high. If these requirements are fulfilled, however, the result may be beyond all expectations.

O5 - Volunteers compile historical data of the flora of the canton Zurich online: a look behind the scenes

Corina Del Fabbro[1], Reto Nyffeler[1,2], Thomas Wohlgemuth[1,3]

[1]Botanical Society of Zurich, Zurich, CH, corina.delfabbro@zbg.ch
[2]University of Zurich, Institute of Systematic Botany, Zurich, CH
[3]Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, CH, thomas.wohlgemuth@wsl.ch

During the last 200 years, the landscape of Zurich, Switzerland, has changed like others: dramatically. Villages expanded to cities, 95% of the wetlands were drained, agriculture intensified, neophytes introduced and human population has sextupled. Evidentially, these changes have profoundly affected the occurrence, distribution and abundance of plant species. However, historical and contemporary

vegetation data have not been compiled and therefore, changes in flora and vegetation cannot be quantified.

The first and only complete flora of the canton is 176 years old. Tens of thousands of additional findings have been reported since. The joint herbaria of the university of Zurich and ETH harbor a great treasure of specimens dating back to 1880–1920. Moreover, an unpublished handwritten manuscript of Eugen Baumann contains detailed locations of all plant species present in the canton between 1870 and 1930. However, the data sources lack an important component to allow immediate mapping and analyzing: digital coordinates.

We developed a citizen science approach to systematically and reproducibly process historical data. Expert volunteers select the relevant herbarium specimens and verify the species identity. Other volunteers take pictures of the specimens and upload them to an online-platform. The localities mentioned in the Baumann manuscript are transliterated and edited to be used online. Volunteers then work from their homes, online: they transliterate specimen labels and georeference localities using historical and contemporary maps. To guarantee reproducibility, all online steps are traceable.

Based on georeferenced historical data from the last 176 years, we will be able to evaluate historical states of the flora. Given the fact that our highly motivated volunteers have prepared 1000 records within only 6 weeks' time, we are confident to comprehensively trace the dynamic change of the flora of the canton Zurich in due short time.

O6- Viel-Falter: Can schools contribute to biodiversity monitoring? Lessons learned from a citizen science project focusing on butterflies

Johannes Rüdisser[1], Erich Tasser[2], Suzanne Kapelari[3], Peter Huemer[4], Ulrike Tappeiner[1,2]

[1]Institute of Ecology, University of Innsbruck, Innsbruck, AT, Johannes.Ruedisser@uibk.ac.at
[2]Institute for Alpine Environment, EURAC, Bozen/Bolzano, IT
[3]Austrian Education Competence Center, University of Vienna, Vienna, AT
[4]Tiroler Landesmuseen-Betriebsgesellschaft m.b.H., Naturwissenschaftliche Sammlung, Innsbruck, AT

Biodiversity assessments and continuous monitoring schemes are an important and generally recognized basis to address the ongoing biodiversity crises. Nevertheless, resources to collect data about biodiversity are and will always be limited. Citizen Science projects seem to be an interesting option to support the collection and processing of biodiversity data and, at the same time generate authentic opportunities for environmental education. The ongoing citizen science project **Viel-Falter** which was launched in 2013 (www.viel-falter.at) aims to investigate if and how trained and supervised students, aged from 6 to 19 years old, are able to systematically collect data about the occurrence of diurnal butterflies. If the achieved data quality is sufficient schools could contribute to a permanent monitoring system. Additionally, we investigate how student's motivation to engage in butterfly monitoring develops during the course of the project and which project factors might be crucial to support a continuous engagement. We developed and applied a specific assessment scheme suitable for young students. From 2013 to 2014 548 students from 15 schools collected data at 35 different sampling sites in Tyrol. While most students reported a high interest and enjoyment in participating in the project in questionnaires conducted at the beginning (83%) and during (87%) the project, the degree of engagement varied a lot amongst the participating schools. The same was true for data quality. Comparing data collected by students with data from butterfly and vegetation experts revealed remarkable variation in data quality amongst the participating schools. To ensure a scientific reliable data quality participating pupils and their teachers require a very high level of support and supervision. We conclude that involving schools in butterfly observation can promote authentic opportunities for environmental education and have positive multiplier effects but resulting data should be handled with care in regards to its quality and reliability.

O7 - The forgotten habitat: engaging citizen scientists in recording biodiversity in our gardens

Silvia Winter[1], Julia Kelemen-Finan[2], Kristina Plenk[1], Bärbel Pachinger[1]

[1]University of Natural Resources and Natural Sciences Vienna, Vienna, AT, silvia.winter@boku.ac.at
[2]Niederösterreichische Naturschutzakademie, Stockerau, AT

Gardens are important habitats for many species in modern cultural landscapes. Citizens can easily observe wildlife in their gardens in rural and urban areas, while researchers may not get access to these sites. Such wildlife observations could be entered to a single database providing a unique large-scale spatial dataset.

Our project "Nature in your backyard – citizen science for schools" joins scientists, NGOs and government departments with 16 schools from Lower Austria and Vienna. We aim to link the presence and relative abundance of hedgehogs, 12 bird and 8 butterfly species, as well as wild bees´ activities, to garden structure and management as well as to the surrounding land use. Pupils use online or printed survey forms to gather information on garden size, type, management and structures as well as on wildlife observations. Each school collects data on the chosen species groups in at least four gardens per school. The scientists and NGOs provide identification guides, experimental protocols and hands-on trainings at the respective garden sites.

In addition, we expanded this science education partnership to a broader citizen science project where we want to involve all gardeners or people attached to gardens to report the presence of hedgehogs in their gardens across Austria. Analogous to the science education partnership, gardeners should report sightings of hedgehogs by using tracking tunnels where footprints of hedgehogs or other animals can be observed. Citizen scientists will complete an online form on garden management and report presence or absence data of hedgehogs in combination with scans or photographs of hedgehog footprints. The wider range and higher number of observations by engaging all interested citizen scientists will lead to better estimations of hedgehog presence in relation to garden structures and management.

We will present first results and discuss challenges in assuring data quality for the different species groups.

O8 - Do school children make good citizen scientists? A midterm evaluation of a citizen science project exploring biodiversity in gardens

Julia Kelemen-Finan[2], Silvia Winter[1], Kristina Plenk[1], Bärbel Pachinger[1], Martin Scheuch[3], Manfred Bardy-Durchhalter[3]

[1]BOKU - University of Natural Resources and Life Sciences, Vienna, AT
[2]NÖ Naturschutzakademie, Stockerau, AT, j.kelemenfinan@gmail.com
[3]University of Vienna, Vienna, AT

The participation of citizen scientists in projects is usually based on voluntary commitment. In the project “Nature in your backyard – citizen science for schools” the situation is slightly different: 16 schools from Lower Austria and Vienna, with pupils ranging in age from 8 to 18, are taking part in a quest to explore the biodiversity of private and school gardens. Here, the initial commitment for participation came from teachers and not the pupils themselves.

The scientific aim of the project is to record data about the presence and relative abundance of hedgehogs, 12 selected bird and 8 butterfly species, as well as wild bees´ activities. The data will be related to parameters such as garden structure, management intensity and the surrounding land use. The main task for the pupils is to collect data on the four groups of animals.

In this paper we focus on the social science aspect of the project, which is to study intrinsic and extrinsic motivation as well as other factors promoting pupils´ commitment to the project. How motivated are individual students when entire school classes take part in a research project, which has been developed by researchers and facilitated by the teachers?

Using a set of indicators we have evaluated the selected approaches with regard to their suitability for motivating pupils of different age groups. Preliminary results show that many pupils seem to have successfully recorded hedgehog and wild bee activities in accordance with the protocols. However, for some of the participating school classes, the correct identification of the bird and butterfly species and the motivation to stick to the respective protocols have proved to be more of a challenge. Possible explanatory factors are discussed. These include differences between age groups, "excitement factor" of the task, teaching styles, as well as the level of autonomy offered to the pupils. Based on our findings, recommendations for future projects are made.

O9 - Citizen Science - potential for increasing scientific and environmental literacy in education

Tabea Turrini[1], Anett Richter[1], Annette Dieckmann[3], Florian Heigl[2], Daniel Dörler[2], Pia Viviani[4], Aletta Bonn[1]

[1]Helmholtz-Centre for Environmental Research (UFZ) - German Centre for Integrative Biodiversity Research (iDiv), Leipzig, DE, tabea.turrini@idiv.de
[2]University of Natural Resources and Life Sciences, Vienna, AT
[3]Arbeitsgemeinschaft Natur- und Umweltbildung e.V., Frankfurt/Main, DE
[4]science et scité, Bern, CH

Citizen Science provides opportunities to create knowledge and new scientific insights into fundamental scientific or society-related problems. Most Citizen Science projects also aim at achieving educational goals. Through learning-by-doing participants can, for example, gain knowledge about ecosystems, develop scientific skills such as identifying species, designing surveys or experiments and analysing data, and raise their awareness for environmental problems and the importance of scientific evidence to address these. These are also typical goals of education programmes. However, synergies of Citizen Science approaches and education programmes are rarely harnessed. We conducted an online-survey among practitioners from Citizen Science projects and environmental education in both formal (schools) and non-formal (leisure time offers) settings in Germany, Austria, and Switzerland, to (1) determine the importance of educational goals in existing Citizen Science projects, (2) highlight good practice to reach these goals and identify challenges, (3) quantify the innovation potential of integrating Citizen Science approaches into the practice of formal and non-formal educational institutions, and (4) identify the needs (structures, policy, funding) for Citizen Science and education to reach its full potential. The results of this survey will be presented.

O10 - Creating deliberation online: Developing a Citizen Science Strategy 2020 for Germany

Anett Richter[1], Lisa Pettibone[2], Katrin Vohland[2], Aletta Bonn[1]

[1]1 Helmholtz Centre for Environmental Research (UFZ)/ German Centre for Integrative Biodiversity Research (iDiv), Leipzig, DE, anett.richter@idiv.de
[2]Natural History Museum Berlin, Berlin, DE

Citizen science is an increasingly popular approach to science, one that brings pro-

fessional scientists together with volunteer scientists, scientific clubs, or interested laypeople. Citizen science has recently gained the attention of science policymakers, increasing the importance of developing a strategy to promote and support citizen science projects. Following the approach used by Socientize at the European level, the GEWISS (*BürGEr schaffen WISSen*, or "Citizens create knowledge") project conducts an online consultation process to aid development of a strategy for citizen science in Germany in 2020. This poster presents the conceptual underpinnings of GEWISS's deliberative approach and discusses the possibilities and challenges of using online deliberation methods for strategy development.

Key Words
Citizen Science Strategy, deliberation methods, strategy development

P1 - Citizen Science for obtaining faunistic and ecological data on bumblebees - first experiences and evaluation

Johann Neumayer[3], Silas Bossert[2], Bernhard Schneller[2], Barbara-Amina Gereben-Krenn[2], Monika Kriechbaum[1], Bärbel Pachinger[1]

[1]University of Natural Resources and Life Sciences, Vienna, AT
[2]University of Vienna, Department of Integrative Zoology, Vienna, AT
[3]Obergrubstraße 18, Elixhausen, AT

Within the last decades, many bee species (Hymenoptera: Apiformes) have been in decline in Middle Europe. In some areas, pollination is no longer a free ecological service. In contrast to honeybees, there is a lack of data concerning the abundance of wild bee species. These species include bumblebees (*Bombus* sp.), which are important pollinators of many wild and cultivated plants. As opposed to most other bee groups, bumblebees are publicly well-known. Furthermore, most of the 43 bumblebee species that occur in Austria can be identified in the field. Nevertheless, a thorough introduction and continuous training is clearly necessary.

In 2014, an Austrian citizen science project started on www.naturbeobachtung.at, focusing on bumblebees. In order to obtain high quality data, a field guide to the bumblebees, determination courses, advice in identifying difficult specimens by means of photo determination and quality control of data by experts have been-integrated into this project.

In the first year, 25 bumblebee species could be documented. In addition, 824 observations, 367 being georeferenced, were reported. Moreover, 1027 postings and 703 photos were uploaded to www.naturbeobachtung.at.

In 2015, the project was expanded by linking it to "Nature in your backyard – citizen science for schools", a project also presented at this conference. Students record bumblebee data in private gardens, using the available facilities and guidance of the platform. Additionally, they provide feedback on the weaknesses of the project.

In conclusion, first experiences show that citizen science can be a valuable opportunity to gain faunistic and ecological data on bumblebees. However, data control represents a crucial part of this approach, since it is indispensable for obtaining reliable data.

P2 - A citizen science approach can help to better understand the taxonomy and ecology of invasive pest slugs in Austria

Daniel Dörler[1], Matthias Kropf[1], Johann Zaller[1]

[1]University of Natural Resources and Life Sciences, Vienna, Vienna, AT, daniel.doerler@boku.ac.at

The invasive slug species *Arion vulgaris* (also known as *A. lusitanicus*) is considered one of the worst invasive alien species in Europe. It is an agricultural/horticultural pest that also causes massive damages in private gardens. The taxonomy of *A. vulgaris* is still matter of much debate, but a number of papers have shown that there is very likely hybridization between the very closely related species *A. rufus*, *A. ater* and *A. vulgaris*. This and the fact that *A. vulgaris* and *A. rufus* cannot be distinguished by morphological/colour features are making species identification very hard. Another aspect that is not well known is which biotic and abiotic parameters actually favour the occurrence of *Arion* species. Using a citizen science approach we studied to what extent past and current rainfall patterns, air temperature, plant diversity and earthworm activity affects the abundance of *A. vulgaris* in private gardens all over Austria. Therefore, over two years about 300 citizen scientists collected slugs in gardens or parks and assessed plants in the vicinity of the sampling site as well as earthworm activity. Photographs of collected slugs will be verified by DNA analysis to find out if there is a similar hybridization in Austria as was already shown for Scandinavia. Preliminary results suggest that a mild winter temperatures and previous-year rainfall are more important influencing *Arion* abundances than vegetation parameters. The relationships between biotic and abiotic parameters will be used to develop sustainable control strategies against this pest slug.

P3 - Citizen science project "StadtWildTiere" Vienna: Red fox observability and influence factors of human-fox encounters

Theresa Walter[1,2], Richard Zink[1], Florian Heigl[2], Johann G. Zaller[2]

[1]Research Institute of Wildlife Ecology, University of Veterinary Medicine Vienna, Vienna, AT, theresa.walter@gmx.at
[2]Institute of Zoology, University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, AT, theresa.walter@gmx.at

The red fox (*Vulpes vulpes*) is one of the most widely distributed mammals in the world. Because of its adaptiveness it has also become one of the most successful users of urban areas in recent years. Urban foxes can also be found in the city of Vienna (Austria), however, our knowledge about their occurrence and distribution is poor. Studying animal occurrence in cities poses different challenges to scientists as covering the complex city area with usual monitoring methods is often cost-intensive. Additionally many habitats frequently favoured by animals are on private properties and therefore hardly accessible to scientists. Citizen science can bridge this gap in inaccessibility and on one hand enables scientists to have many eyes looking for evidence, and on the other hand enhances scientific literacy in society. In this study we use a data set of more than 600 fox sightings collected between 2010 and 2015 and new sightings coming in through the recently established internet-platform “StadtWildTiere.at”. We examine where and when in the city of Vienna the likelihood of a residential encounter with a fox is particularly high. Furthermore we identify which factors influence the observability of urban foxes. Since observations involve both the animal and the observer himself, we distinguish between observer-dependent factors like occupation and education, and fox-dependent factors like habitat surrounding the observation point and food availability. We will also address challenges for data analysis and interpretation involved with presence-only data like fox observations from citizens.

P4 - Citizen Science Project Roadkill: Connecting science, people and habitat fragmentation using European hare as a model organism

Florian Heigl[1], Carina Stretz[1], Wolfgang Steiner[2], Thomas Bauer[3], Franz Suppan[3], Johann G. Zaller[1]

[1]Citizen Science Working Group, Institute of Zoology, University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, AT, florian.heigl@boku.ac.at
[2]Institute of Wildlife Biology and Game Management, University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, AT
[3]Institute of Surveying, Remote Sensing and Land Information (IVFL), University of Natural Resources and Life Sciences Vienna (BOKU), Vienna, AT

Habitat fragmentation by roads is a severe impact for many animal species, particularly for those with high mobility or seasonal migration behaviour. As a consequence, roadkill (i.e. collision of animals with vehicles) is one of the main reasons for the decrease of populations of several animal groups. A species which is often involved in roadkills is the European hare (*Lepus europaeus*). Overall, populations of *L. europaeus* are declining in many regions in Europe resulting in country-specific Red Listing as "near threatened" or "threatened". Although the primary cause of their decline is considered to be the intensification of agriculture it is striking that in the hunting year 2013/14, 19,343 hares were killed on Austrian roads only. For the study presented here we hypothesized, that (I) roadkill data from citizen science projects and data from professionals (e.g. hunters, police) are complementary, (II) hare roadkills occur as an aggregation of events (hotspot) and (III) the surrounding area influences the number of roadkilled hares. To answer these research questions we launched the citizen science project Roadkill (www.roadkill.at) where participants report roadkill findings via a smartphone app or an online form. The data entry includes *inter alia* coordinates of the roadkill location and if possible an image of the roadkill. The handling of the app is very intuitive, hence enabling its integration in teaching at schools or universities. We analysed data from the citizen science project and and compared them with data from a project where roadkills were reported by the police and by hunters. Analyses of the landscape surrounding the scenes of accidents were carried out using land cover data derived from Landsat satellite images. Results of this study are aimed to raise awareness for the frequency and significance of roadkills and could be implemented in nature conservation actions.

END OF SESSION 35

Session 40 - Plants and water - mechanisms, fluxes and experiments from the leaf to the ecosystem
Short title: Water - from the leaf to the ecosystem

CHAIRS: THORSTEN GRAMS, ANSGAR KAMEN, HENRIK HARTMANN

O1 - Heat-drought impacts on tree carbon and water cycling– beyond the stress event

Nadine Ruehr[1], Andreas Gast[1], Almut Arneth[1]

[1]Karlsruhe Institute of Technology, Institute of Meteorology and Climatology - Institute of Atmospheric Environmental Research, Garmisch-Partenkirchen, DE, nadine.ruehr@kit.edu

Heat and drought waves co-occur naturally, but so far we have only a very limited understanding on how plants respond to multiple stresses and their ability to recover. In this study we investigated the response of carbon and water relations to heat and heat-drought waves followed by recovery periods in Douglas-fir and black locust saplings grown under controlled conditions.

Tree carbon and water fluxes responded strongly to the treatments, with largest water deficits occurring under coupled heat-drought stress. Day- and nighttime transpiration increased with high temperatures and evaporative demand as long as water supply was sufficient. Assimilation in both tree species declined strongly under heat and heat-drought conditions while dark respiration increased with stress intensity in Douglas-fir but not in black locust. We found lagged effects on gas-exchange during the recovery periods, likely resulting from tight stomata regulation. Black locust did not compensate for stress-induced growth and biomass losses during recovery. This was in stark contrast to Douglas-fir, in which stem growth continued longer in previously stressed trees, while it had already ceased in the control trees. In summary, high temperature events, specifically in combination with drought, strongly affected tree carbon and water cycling past the actual stress period. Such legacy effects need to be included in vegetation models, to increase accuracy in predicting stress impacts.

O2 - Temperate European tree species show different sensitivities in sap flow to short but frequently occurring summer dry spells.

Nadine Brinkmann[1], Werner Eugster[1], Roman Zweifel[2], Nina Buchmann[1], Ansgar Kahmen[1,3]

[1]ETH Zürich, Zürich, CH, nadine.brinkmann@usys.ethz.ch
[2]Swiss Federal Institute of Forest, Snow and Landscape Research (WSL), Birmensdorf, CH
[3]Department of Environmental Sciences – Botany, University Basel, Basel, CH

Trees from temperate European forests might be particularly vulnerable to drought events given their adaptation to mesic environments with typically continuous water supply and no naturally re-occurring seasonal drought periods.The goal of our work was to assess the drought sensitivity of four common temperate European tree species (*F. sylvatica*, *P. abies*, *A. pseudoplatanus*, *F. excelsior*) to frequently occurring short summer dry spells. We conducted our study in a mature mixed temperate forest at Laegeren, Switzerland in 2012 and 2013. We determined tree water deficit using automatically recorded stem radius changes to assess the water status of the different species with declining soil moisture. To assess drought sensitivity in water relations we monitored the sap flow of all four species. Our findings showed a strong threshold response of tree water deficit to decreasing soil moisture content that was similar for all tree species. However, sap flow showed a strong species-specific response with strongest down regulation for *P. abies*, followed by *F. sylvatica* and *A. pseudoplatanus*. *F. excelsior* showed no significant reduction in sap flow during short summer dry spells. Our study showed that declining soil moisture affected the water status (i.e. tree water deficit) of all four species equally. However, species-specific differences in declining sap flow indicate that in particular spruce is highly drought sensitive, beech and maple have an intermediate drought sensitivity and ash showed no drought sensitivity. In addition, our data show that not only extreme drought events have a significant effect on water relations of common central European tree species but that also more frequently occurring short summer dry spells affect the trees. With the predicted increase in the number of dry and hot days in the future, such information on species-specific drought responses is essential to design sustainable forest management practices for the future.

O3 - Establishment, growth and stem water deficit of Norway spruce (Picea abies) at its dry distribution limit

Walter Oberhuber[1], Albin Hammerle[2], Werner Kofler[1]

[1]University of Innsbruck, Institute of Botany, Innsbruck, AT, walter.oberhuber@uibk.ac.at
[2]University of Innsbruck, Institute of Ecology, Innsbruck, AT

Climate sensitivity of tree growth and establishment will affect the development of forest ecosystems under a warmer and drier climate. We evaluated establishment of Norway spruce (*Picea abies* (L.) Karst.) and the size effect (i.e., saplings vs. mature adult trees) on stem water status and growth in a dry inner Alpine environment (750 m asl, Tyrol, Austria). To this end, time series of basal area increments (BAI) were developed from > 200 trees and related to establishment dates. Furthermore, intra-annual dynamics of stem water deficit (ΔW) and radial growth (RG) were extracted from stem diameter variations, which were continuously recorded by automatic dendrometers and the influence of environmental drivers was evaluated by applying moving correlation analysis (MCA). In adult trees needle water potential (ψ) was also monitored during two growing seasons.Results revealed that (*i*) ΔW and ψwere significantly correlated in adult trees (r = 0,630; $P < 0.05$) and (*ii*) saplings exhibited a more strained stem water status throughout the growing season than mature trees, which explains the significantly lower radial increments in the former (0.16 ± 0.03 mmcompared to 0.54 ± 0.14 mm in saplings and mature trees, respectively). Climate-growth relationships indicated that intra-annual RG and ΔW were most closely related to climate variables that influence transpiration. However, pronounced instability of these relationships was found throughout the growing season. The synchronicity found among BAI and tree establishment suggests that canopy openings increased water availability, which favored establishment and growth of moderately shade-tolerant *P. abies*. We conclude that although *P. abies* is able to regenerate at this drought prone site, strengthened physiological stresses experienced by saplings as opposed to mature trees in response to limited water availability will impair productivity and long-term stability of Norway spruce forests in a warmer climate.

O4 - Isotopic interference of water vapor and leaf water in a mixed forest canopy

Rebekka Bögelein[1], Frank M. Thomas[1], Willy Werner[1], Ansgar Kahmen[2]

[1]University of Trier, Trier, DE, boegelein@uni-trier.de
[2]University of Basel, Basel, CH

Distinguishing the main environmental and ecophysiological drivers of leaf water isotopic enrichment is prerequisite for ecological interpretations of stable hydrogen and oxygen isotopes in plant tissue and transpired vapor and can be achieved by mechanistic modelling. How well these models represent micrometeorological and leaf physiological heterogeneities within the canopies of mature trees and whether these differences vary between angiosperm and gymnosperm trees remains, however, unclear. We aimed at exploring the biophysical causes of leaf water enrichment and its effects on the canopy water vapor along a vertical gradient in mature angiosperm (European beech) and gymnosperm (Douglas fir) trees.

We sampled leaf water and water vapor for d^2H and $d^{18}O$ analyses at varying crown heights (16-28 m) every three hours over two diel cycles. Isotope enrichment models of leaf water were calculated using continuous micrometeorological (e.g. leaf temperature) and branch-level sapflow measurements.

We found that water vapor was not in isotopic equilibrium with source water because the trees exploited isotopically light water from deep soil layers. While the isotopic signatures of water vapor did not show a major vertical gradient, their temporal variation strongly affected leaf water, especially for d^2H. The contribution of transpired water to the ambient air was evident from distinct diurnal cycles of deuterium excess in the water vapor and the positive isoforcing was dominated by the Douglas fir.

Despite the extreme light-induced variability of stomatal conductance and leaf temperature in the vertical gradient, differences in leaf water enrichment only occurred temporally. On the other hand, Douglas fir needle water was significantly more enriched than beech leaf water, and was in isotopic non-steady state most of the time. Leaf water content, stomatal conductance and leaf shape were the key factors determining the different leaf water enrichment of the two species.

We conclude from our data that the different leaf morphological and functional traits of angiosperm and gymnosperm trees strongly affect the isotopic composition of leaf and transpired water while the effects of light-induced canopy gradients in leaf temperature and transpiration rate largely balance each other under well-watered conditions.

O5 - Aboveground water uptake of beech (Fagus sylvatica) and spruce (Picea abies) depending on drought stress intensity

Timo Gebhardt[1], Sebastian Magin[2], Rainer Matyssek[2], Thorsten E. E. Grams[2]

[1]Dept. of Silviculture and Forest Ecology of the temperate Zones, Georg-August-Universität, Göttingen, DE, timo_gebhardt@gmx.de
[2]Dept. of Ecology/Ecophysiology of Plants, Technische Universität München/Weihenstephan, Freising, DE

In regard to climate change with increasing temperatures and extended severe drought periods, the conversion of spruce monocultures to mixed stands of beech and spruce is currently one of the main silvicultural strategies. In this context the detailed knowledge of the parameters modifying the species-specific water balance in mixed forest stands during drought stress is crucial. Previous studies indicate that the capacity of above ground water-uptake of tree species during short rain periods may be underestimated, especially in terms of the capability to increase drought stress tolerance. In a deuterium (D) labeling experiment we investigated the potential of juvenile beech and spruce for aboveground water uptake. The magnitude of aboveground water-uptake and reverse water flow in the xylem were tested in response to three levels of drought stress (“well watered”, “moderate drought” and “severe drought”). After sealing the lower part of the stem and the pot, aboveground parts of plants were submerged for in deuterium labeled water. Subsequently, aboveground parts of plants were covered with another plastic bag to minimize transpiration. After three hours exposition-time, the water-potential was assessed and upper and lower stem and the roots were sampled. Water was extracted via cryo-distillation to measure its delta δD-value. After labeling the ψ-value exceeded the $\psi_{pre\text{-}dawn}$– values in beech and the δD-value of the xylem- water was significant enriched in stem xylem and for the moderate and severe drought treatment also in the roots compared to the untreated control plants. For spruce, data confirmed the enriched δD-value in the upper part of the stem xylem. Our results provide evidence for aboveground water uptake as well as a reverse flow depending on the drought stress intensity. However, the magnitude of aboveground water uptake appears to be higher in beech as compared to spruce.

O6 - Impact of drought intensity on seedling performance of six floodplain grassland species

Kristin Ludewig[1], Jana M. Hanke[1], Bianka Zelle[1], Annette Otte[1], Eva Mosner[2], R. Lutz Eckstein[3], Tobias W. Donath[4]

[1]Institute of Landscape Ecology and Resource Management, Research Centre for Biosystems, Land Use and Nutrition (IFZ), Justus Liebig University Giessen, Giessen, DE, kristin.ludewig@umwelt.uni-giessen.de
[2]Center of Applied Biology, Hochschule Geisenheim, Geisenheim, DE
[3]Department of Environmental and Life Sciences, Biology, Karlstad University, Karlstad, SE
[4]Department of Landscape Ecology, Christian-Albrechts-University Kiel, Kiel, DE

The performance of seedlings is crucial for the survival and persistence of plant species. Although drought is an important reason for seedling mortality, the effects of drought on seedlings were rarely investigated. In a greenhouse study, we exposed one week and three weeks old seedlings of six species to drought events of different intensity. The six species belonged to three plant families. Within each species pair, one species was characteristic of wet and one of dry zones of European floodplain grasslands. We tested the following hypotheses: 1) Drought events reduce the aboveground biomass, the height and the specific leaf area (SLA) of the seedlings; 2) Drought events affect the seedlings of species characteristic of wet grassland zones more (show larger reduction of aboveground biomass, height and SLA) than of dryer grassland zones; 3) Drought events affect younger seedlings more (show larger reduction of aboveground biomass, height and SLA) than older seedlings. Generally, the responses were species-specific. Drought events reduced the aboveground biomass of four species and the height of two species, but increased the SLA of two species. The seedlings of species characteristic of wet and dry grassland zones did not respond in a uniform way. Older seedlings were more affected by the drought events than younger seedlings. Reasons for these unexpected responses will be discussed.

O7 - The role of potassium in optimizing water-use efficiency and drought adaption - from single leaves to whole plants

Bálint Jákli[1], Mehmet Senbyram[1], Kristóf Kovács[3], Merle Tränkner[1], Ershad Tavakol[1], Klaus Dittert[1,2]

[1]Institute of Applied Plant Nutrition, Göttingen, DE, jakli@iapn-goettingen.de
[2]Institute of Plant Nutrition and Crop Physiology at Georg-August-University Goettingen, Göttingen, DE
[3]Institute of Geography at Georg-August-University Goettingen, Göttingen, DE

The increasing probability of seasonal droughts and the prospects of freshwater scarcity emphasize the importance of traits such as nutrient- and water-use efficiency (WUE) in agro-ecosystems. At the leaf level, water-use efficiency (leaf-WUE) is defined as the intrinsic ratio of net CO_2 assimilation and stomatal conductance to water vapor. At the whole-plant level, WUE can be expressed as dry matter produc-

tion per unit of transpirational water loss (biomass-WUE). When exposed to drought, plants have different strategies to enhance WUE (e.g. optimizing stomatal aperture, enhancing root growth, optimizing canopy morphology). However, these processes require adequate nutrient supply. In this context, potassium (K) is known to be a key nutrient as it is needed for a number of processes related to drought adaption (e.g. stomatal- and osmotic adjustment). We conducted a number of greenhouse experiments aiming to understand direct and indirect effects of K availability on drought tolerance and WUE of crops (wheat, sunflower, barley) at both leaf and whole plant level. Plants were grown hydroponically with various level of K supply. Drought stress was applied using PEG-6000. Leaf-WUE was determined in regular intervals. Thermal imaging and 3D-laser-scanning were used to determine the effects of canopy architecture on spatial variation in transpiration. Whole plant transpiration was recorded by an automated balance system and productivity estimated using a remote imaging approach. Additionally, nocturnal transpiration as well as respiration and their contribution to whole plant WUE were determined. All experiments clearly showed that K supply does not affect leaf WUE, but significantly increases biomass-WUE, particularly under conditions of drought. The latter suggest that leaf-WUE does not necessarily represent WUE on a whole plant level since plant transpiration is substantially affected by canopy architecture that will be discussed intensively in this presentation.

O8 - Allocation to stored C pools during recovery from severe drought

Lucia Galiano[1,2], Galina Timofeeva[3], Matthias Saurer[3], Rolf Siegwolf[3], Jordi Martinez-Vilalta[4,5], Arthur Gessler[1]

[1]Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, CH, lucia.galiano@wsl.ch
[2]Albert Ludwigs University Freiburg, Freiburg, DE, lucia.galiano@wsl.ch
[3]Paul Scherrer Institute PSI, Villigen, CH
[4]Centre for Ecological Research and Forestry Applications CREAF, Cerdanyola del Vallès, ES
[5]Autonomous University of Barcelona UAB, Cerdanyola del Vallès, ES

Climate-related drought has been identified worldwide as a primary driver of recent tree and forest mortality, thus urgent need has raised to predict how forests will cope with increasing stress. While much research focused so far in understanding physiological tree death during drought, subsequent tree's ability to recover the physiological function is critical for forest fate and remains much less investigated. Although plants store non-structural carbon (NSC) to buffer against times of negative carbon balance during drought and following recovery phases, the regulation of NSC levels to meet C demands remains unclear. Here tree saplings (*Tilia platyphyllos* and *Pinus sylvestris*) were subjected to experimental severe drought during 10 weeks and stored NSC pools (soluble sugars, starch, neutral lipids) were monitored over time at the whole-tree level. Trees were well watered afterwards and simultaneous ^{13}C labeling allowed to track C allocation to stored NSC pools and biomass during a time span of 20 days. Although the results are still preliminary it seems that lipids are little used during drought for both species. By contrast, soluble sugars and starch are significantly depleted. Compound-specific ^{13}C analyses seem to indicate that both species allocate C assimilates primarily to soluble sugars, and only when a certain amount has been replenished starch starts to build up. These preliminary results would indicate the existence of certain thresholds of soluble sugars before other functions as storage are re-established during tree recovery from drought.

O9 - Spring growth compensates preceding drought induced sink limitation in Pinus nigra but not in Pinus sylvestris

Christoph Bachofen[1,2], Barbara Moser[2], Thomas Wohlgemuth[2]

[1]ETH Zürich, Zürich, CH, christoph.bachofen@wsl.ch
[2]WSL Birmensdorf, Birmensdorf, CH, christoph.bachofen@wsl.ch

In the central Alps, *Pinus sylvestris*, the dominant tree species of low elevation forests, has shown increased mortality following the exceptional 2003 summer drought. To quantify effects of drought stress on tree carbon limitations, we exposed 1 year-old seedlings of *P. sylvestris* and the more drought tolerant *Pinus nigra* to severe summer drought (no rain Jun-Sep) in two consecutive years in a common garden experiment located at the bottom of central Alpine Valais valley. In both years, we measured the biomass and non-structural carbohydrate (NSC) content of needles, shoot and roots before and at the end of the drought treatment, and the stomatal conductance during the course of a day in late summer.

Stomatal conductance of *P. sylvestris* and *P. nigra* was severely reduced during the drought (27% and 36% in 2013; 65% and 80% in 2014) and the drought resulted in a significantly lower biomass in both species (69% and 76% in 2013; 43% and 66% in 2014). As expected, concentrations of sugar and starch were much higher in all three parts of the drought-stressed seedlings (173% and 164% in 2013; 159% and 112% in 2014). Sugar concentrations of the trees in the drought treatment returned to control levels under natural precipitation in the following spring, whereas starch levels remained significantly higher. While the seedlings of *P. nigra* were able to compensate for their biomass shortfall in the following spring, *P. sylvestris* was not and suffered a more pronounced drought stress. The latter was also reflected in a higher sugar and starch accumulation during the summer drought. Growth rates of either species in spring were not correlated with NSC levels at the end of the first summer drought. We therefore assume that the excess NSC in drought-stressed seedlings does not enhance their resilience after a severe drought event, but that other species-specific traits enabled the seedlings of *P. nigra* to compensate for the biomass shortfall after the severe summer drought.

O10 - European beech and Norway spruce in competition for water effects of drought and inter-specific mixture

Michael Goisser[1], Christian Blanck[1], Karl-Heinz Häberle[1], Thorsten E.E. Grams[1], Rainer Matyssek[1]

[1]Chair for Ecophysiology of Plants, Department of Ecology, Technische Universität München, Freising, DE, goisser@mytum.de

Mixtures of Norway spruce (*Picea abies* (L.) Karst.) and European beech (*Fagus sylvatica* L.), two tree species of high ecological and economic relevance in Central Europe, have gained increasing attention, as mixed-species systems appear to warrant ecological and socio-economic services to an extent similar, or even better, as compared with artificial tree monocultures. Under climate warming, however, with severe and frequent summer drought, water limitation may become crucial in modifying prevailing competitive interaction between beech and spruce. This uncertainty urges to close the existing knowledge gap of underlying mechanisms of species interaction in mixed beech-spruce forests. Anticipating climate change, we investigate species-specific drought response strategies as well as mixture-effects in a mature mixed beech-spruce forest under conditions of severe and annually repeated summer drought induced via experimental throughfall exclusion (Kranzberg roof experiment). At the leaf level, high drought susceptibility of spruce was mirrored by a distinct decrease in stomatal conductance and net CO_2 uptake rate (both about 60%) in response to throughfall exclusion, entailing photoinhibition during days of high insolation. In beech, the response to throughfall exclusion was less pronounced, yet significantly reducing stomatal conductance (>35%) and net CO_2 uptake rate (>15%) during extended drought. At the whole tree level, xylem sap flow during spring and early summer was found to be higher in inter-specific spruce, but lower in inter-specific beech, as compared to intra-specific spruce and beech. Under extended drought, however, xylem sap flow of inter-specific spruce fell below that of spruce under intra-specific growth conditions. We conclude in dry years, temporal complementarity of water consumption to be one of the key mechanisms determining competitive interactions between evergreen spruce and deciduous beech. Positive interaction effects, however, appear to be cancelled during extended periods of drought.

O11 - Drought response of temperate trees: scaling from the cell to the stand

Christoph Leuschner[1]

[1]Plant Ecology, University of Göttingen, Göttingen, DE, cleusch@gwdg.de

Droughts may occurr at increasing frequency and intensity in many regions of the temperate zone if climate change scenarios become reality. This may threaten forest health and productivity. Recent research efforts on the drought response of trees focus mostly on the hydraulic architecture of trees, hydraulic failure and carbon starvation, but rarely address other aspects of the drought response such as fine root mortality, leaf area reduction, stem growth reduction, and shifts in C allocation between canopy and root system. I shall attempt to summarize some recent findings on the drought sensitivity and drought adaptation of temperate trees from different organisation levels (cellular to stand level) in order to give a somewaht more comprehensive view of the drought response of temperate trees.

P1 - Pinus sylvestris switches respiration substrates under shading but not during drought

Henrik Hartmann[1], Sarah Fischer[1], Stefan Hanf[2], Torsten Frosch[2], Gerd Gleixner[1], Jürgen Popp[2], Susan Trumbore[1]

[1]Max-Planck Institute for Biogeochemistry, Jena, DE, hhart@bgc-jena.mpg.de
[2]Leibniz Institute of Photonic Technology, Jena, DE

Reduced carbon assimilation during prolonged drought forces trees to rely on stored carbon to maintain vital processes like respiration. It has been shown, however, that the use of carbohydrates, a major carbon storage pool and main respiratory substrate in plants, strongly declines with deceasing plant hydration. Yet, no empirical evidence has been produced to what degree other carbon storage compounds like lipids and proteins may fuel respiration during drought.

We exposed young scots pine trees to carbon limitation using either drought or shading and assessed respiratory substrate use by monitoring the respiratory quotient, $\delta^{13}C$ of respired CO_2 and concentrations of the major storage compounds, i.e. carbohydrates (COH), lipids and amino acids.

Generally, respiration was dominated by the most abundant substrate. Only shaded trees shifted from carbohydrate-dominated to lipid-dominated respiration and showed progressive carbohydrate depletion. In drought trees respiration was strongly reduced and fueled with carbohydrates from also strongly reduced carbon assimilation. Initial COH content was maintained during drought probably due to reduced COH mobilization and use and the maintained COH content may have prevented lipid catabolism via sugar signaling.

Our results suggest that respiratory substrates other than carbohydrates are used under carbohydrate limitation but not during drought. Thus, respiratory substrate change cannot provide an efficient means to counterbalance carbon limitation under natural drought.

P2 - Doubting drought: grassland productivity in response to seasonal droughts

Claudia Hahn[1,2], Sara Hasler[1], Florian Cueni[1], Andreas Lüscher[2], Ansgar Kahmen[1]

[1]University of Basel, Basel, CH, claudia.hahn@unibas.ch

[2]Institute for Sustainability Sciences ISS, Agroscope, Zurich, CH, claudia.hahn@unibas.ch

Under future climate change extreme weather events, including droughts, are supposed to occur more often. The effects of these extreme drought events on grasslands are of high interest, since large parts of the agricultural land in temperate, tropical and arid regions consist of grasslands.Several previous studies have assessed the impacts of drought on grasslands by experimental removal of precipitation using rainout shelters. Recent work with the attempt to synthesize the outcome of these studies has produced mixed results. Largely, this is because previous studies have differed largely in their experimental design, including the intensity of the drought applied and the timing of the drought event in the growing season. Thus, key questions regarding grassland biogeochemistry and ecohydrology can yet not be answered. In particular the impact of drought events occurring at different times of the growing season is a question that still remains unresolved.

To overcome this problem we have installed a large field experiment, specifically designed to test the effects of drought at different times of the growing season (spring drought, summer drought, autumn drought) on the physiological performance and productivity of different European grassland species. Specifically, we designed our experiment to disentangle the effects of seasonal droughts and the sensitivity of different plant phenological stages by growing monocultures of different grassland species that vary in the timing of their phenology.

Preliminary results from the first year of the experiment indicate that above- and belowground biomass production differs strongly in their reaction to drought. In my talk I want to present detailed results of our experiment for two growing seasons (2014 and 2015) for above-and belowground productivity, fodder quality and ecohydrology.

P3 - Leaf water dynamics: Insights from combined measurements of infrared transmission, gas exchange and stomatal responses

Hartmut Kaiser[1]

[1]Botanisches Institut der Christian-Albrechts-Universität zu Kiel, Kiel, DE, hkaiser@bot.uni-kiel.de

Leaf water content (LWC) is permanently changing under fluctuating transpiration rate and sap flow through the petiole. LWC in turn influences e.g. stomatal responses and osmotic adjustments. It therefore plays a key role in the regulatory network stabilizing leaf hydration. Direct recording of LWC alongside with other parameters concerning water and its flows in leaves is therefore desirable. Unfortunately, this is difficult to achieve with the available techniques. These either influence local leaf water content or restrict the control of the experimental leaf micro-environment. Many of them moreover cannot easily be combined with other techniques like gas-exchange. Here it is shown, that measurement of light absorption in the NIR range with a newly developed device allows precise and continuous recording of LWC. Measurements utilize the specific absorption spectrum of liquid water and can be performed in-situ under ambient light and freely selectable experimental conditions. The measurement principle allows miniaturization and can therefore be integrated into many different experimental settings. Measurements of LWC during disturbance and readjustment of water balance by stomatal responses are presented. Simultaneous measurement of LWC and transpiration of stomatal responses allows to budget the leaf water reservoir and its influx and afflux with high temporal resolution. Simultaneously measuring stomatal responses with a microscope gives a complete picture of the involved stomatal and hydraulic processes and the dynamic properties of the involved positive and negative feedback-loops .

P4 - Water use efficiency of willow and poplar in short rotation coppice in relation to soil water supply and tree and stand structure

Markus Schmidt[1], Dieter Murach[1]

[1]Hochschule für nachhaltige Entwicklung Eberswalde – Eberswalde University for Sustainable Development, Eberswalde, DE, Markus.Schmidt@hnee.de

Short rotation coppice (SRC) systems of fast growing tree species such as *Populus spp.* or *Salix spp*. offer, besides providing renewable biomass for energetic or material use, various ecosystem services such as reduction of soil erosion by wind and surface runoff or increasing biodiversity, particularly on open, cleared agricultural lands. Compared to traditional annual agricultural crops, SRC offers additional benefits such as reduced need for agrochemicals, reduced soil compaction due to less frequent machinery visits. On the other hand, land use change from annual crops to perennial, deep-rooting woody crops may also affect the local water balance, as the transpiration rates may change due to species-specific differences in stomatal regulation, a larger root-extractable soil volume, and differences in tree and stand structure, the latter also affecting interception. In this study we assessed the trade-off between water use and productivity, expressed as water use efficiency WUE_p, in relation soil water availability and tree and stand structure.

We selected plantation sites of poplar (clone 'Max 1', *Populusmaximowiczii x P. nigra*) and willow (clone 'Inger', *Salix triandra*x *S. viminalis*) with gradients in distance to groundwater and soil water supply. Transpiration was assessed measuring xylem sap flow, and annual aboveground woody biomass production from harvests. Annual WUE_p ranged from 1.2 to 10 g kg^{-1} in poplar and from 4.5 to 13 g kg^{-1} (preliminary results) in willow. Analyses suggest lower WUE_p in well water-supplied trees and in wider spaced parts of the stands with low LAI, but also in suppressed trees in denser parts of the stands. Highest WUE_p was observed in trees with lesser water supply at relatively high LAI (around 6 m^2 m^{-2}). These findings highlight the importance of the interplay between structure and function for a sustainable production and management of SRC and related land use types.

P5 - ClimAgro- understanding the drivers of water balance in changing alpine grasslands using small-scale lysimeters

Georg Frenck[1], Nikolaus Obojes[2], Ulrike Tappeiner[1,2], Johannes Rüdisser[1], Erich Tasser[2]

[1]Institute of Ecology, University of Innsbruck, Innsbruck, AT
[2]Institute for Alpine Environment, EURAC, Bozen/Bolzano, AT

Technological and social development, land-use strategies and environmental changes strongly affect the degree of utilisation in alpine agro-ecosystems. Equally, the functioning of these systems and the services they provide are also subject to the same set of drivers. Patterns of biodiversity, productivity, nutrient and water cycling vary distinctively along the gradients of agricultural intensity and environmental characteristics. Hence, defining the interplay of the anthropogenic and natural drivers which influence the different components of the water balance in alpine ecosystems is essential for informing long-term projections concerning the provision of freshwater from mountain regions. Employing a network of small-scale lyismeters, the ClimAgro project seeks to investigate how management intensity and environmental change may affect the ecological components of water cycling in grasslands of two contrasting regional alpine climates. The data gathered within ClimAgro, comprising also manipulations of temperature, precipitation and agricultural intensity, will characterise changes in the individual divers of ecological water cycling and allow decomposing the hydrological coupling of the soil-plant-atmosphere system. The combination of *in situ* manipulation and transplantation of vegetation monoliths will further allow outlining methodological differences in the two major approaches used to investigate climate change effects on vegetation properties.

Here, we present the details of the ClimAgro project with respect to experimental design, sampling strategy and research infrastructure. A comprehensive summary of the small-scale lysimeter approach, field site characteristics and measurements scheme as well as preliminary results will visualise how ClimAgro seeks to investigate the eco-hydrology of alpine grassland ecosystems under climate and management change.

END OF SESSION 40

Session 44 - Effects of land use changes on functional traits in animal communities and consequences for ecosystem functioning
Short title: Animal traits, land use, and ecosystem functions

CHAIRS: CATRIN WESTPHAL, PÉTER BATÁRY, KLAUS BIRKHOFER, JOHAN EKROOS

O1 - Phylogenetic and functional response of carabid community structure to conversion of arable land in flowering fields

Dennis Baulechner[1], Frank Jauker[1]

[1]department of animal ecology, JLU Giessen, Giessen, DE, dennis.baulechner@allzool.bio.uni-giessen.de

Flowering fields are considered to be a promising conservation management strategy for enhancing pollinator diversity in the landscape. However, the impact of this measure on non-pollinating insects is poorly understood. We analyzed changes in carabid beetle community composition before and after the establishment of flowering fields in arable land. We particularly focused on the response of non-target species that actually prefer the conditions of agricultural land. To understand the functional consequences of changes in community composition we used COI gene trees to reconstruct the phylogenetic community structure and analyzed, whether traits are shared by related species. We expected phylogenetically clustered communities in case these traits are filtered by environmental conditions.

We used the community data from 22 flowering fields sampled in 2011 (before conversion) and 2012 (after conversion), consisting of 6841 individuals from 84 species. We found no changes in species richness or phylogenetic diversity after establishment of the flowering fields. In contrast, species turnover resulted in significant changes of trait distribution and phylogenetic relatedness. Before the conversion, body size was evenly distributed within the arable field communities with carnivorous species being the dominant trophic group. The flowering fields of the second year, however, were dominated by medium-sized species and the share of herbivorous and carnivorous species became identical. Reduction in body size variability correlated with phylogenetic clustering, which can be explained by the phylogenetic signal of body size.

We conclude that environmental filtering for medium sized beetles drives niche differentiation regarding food preference. Carabids colonizing flowering fields tend to have a similar size and are thus forced to use different food sources. Hence, environmental filtering and niche differentiation are not mutually exclusive but can complement or even facilitate each other. Establishment of flowering fields may thus reduce the genetic diversity of taxa adapted to agricultural management by homogenizing the distribution of functional traits.

O2 - Landscape and local effects on interspecific and intraspecific functional diversity of pollinators

Ingo Grass[1,2], Jörg Albrecht[2,5], Dana Berens[2], Tim Diekötter[4], Frank Jauker[3], Daniela Warzecha[3], Volkmar Wolters[3], Nina Farwig[2]

[1]Georg-August-Universität Göttingen, Göttingen, DE, ingo.grass@agr.uni-goettingen.de
[2]Philipps-Universität Marburg, Marburg, DE, ingo.grass@agr.uni-goettingen.de
[3]Justus-Liebig-Universität Giessen, Giessen, DE
[4]Christian-Albrechts-Universität zu Kiel, Kiel, DE
[5]Polish Academy of Sciences, Krakow, PL

Functional diversity (FD) of pollinators can increase plant reproductive output and the stability of plant-pollinator communities. Yet, in times of world-wide pollinator declines, the relative contributions of landscape and local effects on pollinator FD remain poorly understood. In addition, most research so far has focused on interspecific FD within pollinator communities, neglecting the potentially large intraspecific FD that may occur among individuals of single pollinator species.

Here, we investigated how landscape effects (land-use as measured by the proportion of (semi)natural habitat in 500 m radius) and local effects of plant communities (species origin, flower morphology) relate to 1) the interspecific FD of 17 pollinator communities in a South African landscape and 2) the intraspecific FD of *Bombus terrestris* agg. sampled on 14 wildflower plantings in a temperate agricultural landscape.

Overall, these studies show that increasing land-use leads to a loss in interspecific as well as intraspecific FD of pollinators. These losses can occur despite unaltered species richness, and are mediated by specific pollinator functional traits. Thus, negative effects of increasing land-use were mainly mediated by pollinator body size, with a loss in variation in body size in the South African landscape and a decrease in the mean body size of workers of *Bombus terrestris* agg. in the temperate study. In contrast, plant species origin and flower morphology affected both the interspecific and intraspecific FD within pollinator traits such as proboscis length. Here, pollinators of exotic plants in the South African landscape had higher interspecific FD in proboscis length than native plants, whereas flower height, diameter and shape determined the intraspecific FD and mean proboscis length of *Bombus terrestris* agg. in the temperate study.

Taken together, our studies show that: 1) Losses in interspecific FD of pollinators may occur despite species richness being unaffected. 2) Both landscape and local effects drive interspecific and intraspecific FD of pollinators, whereby the relative importance of the drivers depends on the functional traits investigated. 3) Intraspecific FD of pollinators can be large and should receive more attention.

O3 - Prey diversity promotes functional richness of ground beetles in agricultural systems

Viktoria Mader[1], Simon Thorn[2], Klaus Birkhofer[3], Eva Diehl[1], Volkmar Wolters[1]

[1]Department of Animal Ecology, Justus Liebig University, Giessen, DE, viktoria.l.mader@allzool.bio.uni-giessen.de
[2]Bavarian Forest National Park, Grafenau, DE
[3]Department of Biology, Biodiversity and Conservation Science, Lund University, Lund, SE

Functional richness is a commonly used measure of community-level functional diversity that often increases with local species richness, but might additionally be affected by the availability of food resources and habitat and landscape characteristics. Although ground beetles (Coleoptera: Carabidae) are a well-studied invertebrate taxon, our understanding of the factors that determine their functional richness at the level of local assemblages is rather poor. We sampled 12304 ground beetles and 33599 potential prey arthropods at twelve study sites, which differed in habitat type (organically managed cereal fields versus sown flower-rich fields) along a gradient of landscape complexity. We used null-models to control observed functional richness by species richness of ground beetles and linear models for testing the influence of landscape complexity, local habitat type and prey diversity on standardized effect size of functional richness of ground beetle assemblages. Our analyses indicate that prey diversity significantly affected the functional richness of ground beetle assemblages. In contrast, habitat type and landscape complexity did not influence this parameter. This suggests that prey characteristics but not habitat attributes determine the functional structure of ground beetle assemblages within the range of environmental conditions investigated. Strategies that focus on the conservation of total arthropod diversity may therefore also be suitable for promoting the functional diversity of generalist predators in agro-ecosystems.

O4 - Extending trait-based approaches to multi-trophic levels to assess ecosystem processes - First attempts and perspectives

Marco Moretti[1], Francesco de Bello[2,9], Sébastien Ibanez[1,4], Karolina Bíla[1,3], André T. C. Dias[5], Matty P. Berg[6,7]

[1]Biodiversity and Conservation Biology, Swiss Federal Research Institute WSL, Birmensdorf, CH, marco.moretti@wsl.ch
[2]Institute of Botany, Czech Academy of Sciences, Třeboň, CZ
[3]Department of Biodiversity Research, Division of Ecosystems Analysis, Global Change Research Centre AS CR, České Budejovice, CZ
[4]Université de Savoie, UMR CNRS 5553, Laboratoire d'Ecologie Alpine, Le Bourget Du Lac, FR
[5]Departamento de Ecologia, Instituto de Biologia Roberto Alcantara Gomes, Universidade do Estado do Rio de Janeiro – UERJ, Rio de Janeiro, BR
[6]Department of Ecological Science, Faculty of Earth and Life Sciences, VU University Amsterdam, Amsterdam, NL
[7]Groningen Institute of Evolutionary Life Sciences, University of Groningen, Groningen, NL

[8]Institute of Botany, Czech Academy of Sciences, Třeboň, CZ
[9]Department of Botany, Faculty of Sciences, University of South Bohemia, České Budějovice, CZ

Many ecosystem functions rely on interactions among primary producers and other trophic levels. However, the mechanisms through which these interactions influence the functioning of ecosystems are poorly understood. How functional composition (community weighted mean trait values, CWM and community traits' variation, FD) mediate impacts of environmental change on ecosystem processes delivered by multiple trophic levels remains little understood.

We present two examples illustrating a) a novel experimental framework to disentangle the relative effects of CWM and FD in leaf litter macrodetritivore model system, and b) a qualitative application of the response-effect traits framework on a plant–grasshopper trait linkages explaining variations in fodder production under different management regimes.

We discuss about some possible drawbacks when replacing measured physiological and biomechanical traits underlying ecosystem processes and trophic interactions by trait database and literature values or by trait proxies that are either not directly related to the process under study or were not validated beforehand.

O5 - The reaction of communities and ecosystems to extreme climate events: a trait approach

Matty P. Berg[1], Astra Ooms[1], André T.C. Dias[1]

[1]VU University Amsterdam Department of Ecological Science / Section Animal Ecology, Amsterdam, NL, m.p.berg@vu.nl

One ecologically important aspect of climate change is the increase in frequency and duration of extreme events. These climate events, such heat waves, dry spells or flooding have a larger impact on interacting organisms and ecosystems than gradual changes in the average climate. One of the Herculean tasks we face as ecologists is to understand and predict how climate change will impact the community of functional important organisms, such as soil fauna, and how shifts in community composition affect ecosystem processes.

It has been proposed that ecological generality will improve with a shift from a nomenclatural approach focusing on species number and identity to a more functional approach focusing on species' functional traits. Trait-based approaches can strongly reduce context dependency. We have used a response-to-effect trait framework to understand how precipitation-induced changes in soil moisture conditions affect plants, plant litter, macrodetritivores and their effect on litter decomposition. First, we measured drought and inundation resistance of 80 species of macrodetritivores (isopods, millipedes, earthworms) under standardized laboratory conditions andfound that interspecific dissimilarity in functional traits explained shifts in community composition across landscape soil moisture gradients. Also, species can be aggregated in response groups based on similarity in trait values. Second, experimentally we showed that macrodetritivore community response to drought and inundation stress could be forecasted from resistance traits and resulted in significant effects on litter decomposition, a key ecosystem process that could be forecasted from species effect traits (litter consumption).

These results suggest that the impact of climate extremes on ecosystems can be predicted from the functional traits and trait linkages of species. These findings contribute to the increasing need to generate empirically tested, mechanistic predictions on the effect of global changes on functionally important organisms and their effect on ecosystem processes.

O6 - Response of arthropod traits to land use and their effects on herbivory

Martin M. Gossner[1], Nadja K. Simons[1], Sebastian T. Meyer[1], Wolfgang W. Weisser[1]

[1]Technische Universität München, Freising, DE

Analyses of shifts in species traits have increased our understanding of how environmental drivers such as land use affect the composition of arthropod communities and related processes. There are, however, few studies on which traits in the arthropod community are affected by environmental changes and which traits affect ecosystem functioning. We assessed grassland arthropod communities and arthropod caused herbivory on a total of 150 managed grasslands which represent the range of land-use intensity within three regions of Germany in the year 2013. We additionally compiled traits for more than 300 species including Araneae, Coleoptera, Hemiptera, and Orthoptera from literature sources. Using structural equation models, we tested whether land-use intensity affects a number of functional traits of arthropod communities and whether trait differences changes levels of herbivory. We also included a direct effect of land-use intensity to herbivory.

We found that land-use intensity affected the mean body-size (negative) and dispersal ability (positive) of the herbivore community. Although abundance of herbivores did not respond to land-use intensity, increased herbivore abundance, but not proportion of herbivores, appeared as strong driver of herbivory. In addition, the decrease in herbivore body size in response to increasing land-use intensity decreased herbivory, most likely because small species consume less plant biomass. Our results suggests that a negative effect of land-use intensity on herbivory is mediated by a change in the arthropod trait composition while a remaining direct effect indicates potential additional mechanisms not explained by the tested traits.

O7 - Crop phenology influences species-specific trophic functions of beneficial and harmful ants in tropical agroforestry

Pierre Gras[1], Teja Tscharntke[1], Christoph Scherber[1], Aiyen Tjoa[2], Alfianus Rumede[3], Yann Clough[1,4]

[1]G.-A. University Göttingen, Agroecology, Göttingen, DE, pgras@gwdg.de
[2]Tadulako University, Faculty of Agriculture, Palu, ID
[3]Klabat University, Department of Agriculture, Manado, ID
[4]Lund University, Centre for Environmental and Climate Research, Lund, SE

Arboreal ants play a plastic and ambivalent trophic role feeding both plant-derived resources and arthropod prey. In cacao agroforestry, ants are important drivers of arthropod communities, pest and disease incidence and crop yields.

We investigated how trophic positions of dominant arboreal ants changed with temporal patterns of tree phenology, using a well-studied cacao agroforestry system in Central Sulawesi, Indonesia. We reared two dominant, arboreal ant species - *Dolichoderus thoracicus* and *Philidris* cf. *cordata* - and established 48 colonies in 12 experimental plots. Between flowering and harvest we consecutively surveyed (5 times) all plots to estimate colony size, cacao tree phenology and to collect samples for stable isotope analysis.

Our study showed that diets of arboreal ants changed with fruit development and availability of food. When more fruits were available the trophic level of both species, indicated by $\delta^{15}N$ values of ant larvae, were lower and colony sizes were smaller. Most likely, these effects were caused by a changing availability of mealybugs, which are tended by the ants to produce honeydew, as well as the availability of potential prey (caterpillars) on the trees. The honeydew availability had impacts on the detection time of exposed prey on the trees, which confirms our expectation that shifts in phenology and associated changes in food sources can affect the predatory function of ants. These changes were species-specific and increased caterpillar abundances were accompanied with increased $\delta^{15}N$ signatures of *D. thoracicus* but not *P. cordata*. The capability to use additional prey may help to explain why *D. thoracicus* is reported as beneficial and *P.* cf. *cordata* as yield impairing pest species in cacao agroforestry.

P1 - Cumulative effects of landscape configuration and farming practice shape bird communities and avian nest predation

Christoph Gayer[1,4], Kornélia Kurucz[2], Christina Fischer[3], Teja Tscharntke[1], Péter Batáry[1]

[1]Georg-August-University, Agroecology, Göttingen, DE, christoph.gayer@hfwu.de
[2]University of Pécs, Faculty of Sciences, Institute of Biology, Pécs, HU
[3]Technische Universität München, Restoration Ecology, Research Department Ecology and Ecosystem Management, Freising-Weihenstephan, DE
[4]Nürtingen-Geislingen University, Department of Landscape Architecture, Environmental-

and Urban Planning, Nürtingen, DE, christoph.gayer@hfwu.de

Beside food shortage and lack of nesting sites caused by agricultural intensification, avian nest predation might be an important mechanism contributing to the decline of farmland birds. Although both landscape configurational heterogeneity and compositional heterogeneity may affect bird communities within crop fields , most studies focus on landscape compositional heterogeneity. Historically established differences in agricultural policies between East and West Germany provide an opportunity to compare effects of small vs. large scale agricultural landscapes, i.e. landscapes with high vs. low configurational heterogeneity, in close spatial proximity. We studied birds and nest predation in pairs of organic and conventional winter wheat fields (n=36) within a small field size landscape in West (9 pairs) and large field size landscape in East (9 pairs) along the former inner border in central Germany. Bird abundance and species richness was assessed at the field edge and centre, where we also exposed 4+4 artificial ground nests baited with one Quail and one plasticine egg each for assessing nest survival. Neither farming practice nor landscape configuration alone had significant effects on bird abundance or species richness, but nest predation was higher in East than West and in conventional than organic fields. Most birds were confined in the field edges (with the exception of skylark) coupled with an elevated nest predation. An exception was found for organic field centres in small scale landscapes where bird abundance and richness did not decrease from edge to centre, as well as no higher nest predation rate in comparison to conventional fields occurred. Results reveal the positive cumulative effect of small scale landscapes in combination with organic farming for birds within agricultural landscapes. To enhance ecological value of field centres as suitable bird habitat reduction of field size in combination with organic farming might be an appropriate measure.

P2 - You are what you eat: Specialisation of saproxylic beetle interaction networks depends on trophic level

Beate Wende[1], Martin Gossner[2], Karl Eduard Linsenmair[1], Wolfgang Weisser[2], Ingolf Steffan-Dewenter[1]

[1]Department of Animal Ecology and Tropical Biology, Biocenter, University of Würzburg, Würzburg, DE, beate.wende@uni-wuerzburg.de
[2]Department of Ecology and Ecosystem Management, Terrestrial Ecology Research Group, Technische Universität München, München, DE

During the last centuries, intensive management practices have substantially altered the diversity, stand- and age-structure of erstwhile natural forests in Europe, which severely affected associated biota and related ecosystem functions. Especially species numbers of deadwood-dependent organisms decreased at high rates due to habitat loss. The low amount of dead wood resources in managed forests has been identified as main cause for the decrease of saproxylic species, but studies of interaction networks of deadwood-inhabiting beetles is scarce. Moreover, the specialisation of different functional groups of saproxylic beetles on deadwood resources in a tree species context and under different management regimes is poorly understood. We investigated in a large-scale manipulative experiment the interaction networks of saproxylic beetles. A total of 688 deadwood logs of 13 tree species in 27 forest sites along a forest management gradient in three distinct regions across Germany were exposed. By using stem eclectors, interactions of saproxylic beetle species with the dead wood resources were recorded for three years in monthly intervals. All speciemen were allocated to three feeding guilds (xylophages, mycetophages and predators). We asked whether trophic guilds of saproxylic beetles show differences in specialisation degree to the deadwood resources. Furthermore, we investigated whether specialisation of saproxylic beetles decrease with the intensification of forest management and whether the ongoing decomposition of the dead wood resources effects the specialisation degree by comparing the results of three years.

P3 - Functional traits of generalist predator communities explain the level of natural pest control in an agroecosystem

Adrien Rusch[1], Klaus Birkhofer[2], Riccardo Bommarco[3], Henrik G. Smith[2], Barbara Ekbom[3]

[1]INRA, Bordeaux, FR, adrien.rusch@bordeaux.inra.fr
[2]Lund University, Lund, SE
[3]SLU, Uppsala, SE

Natural pest control is a major ecosystem service supporting agricultural production. The relationship between predator community composition and predation rates of pests remains poorly investigated. A deeper understanding of the processes shaping interaction strength in agroecosystems is needed if we are to accurately predict natural pest control services. Functional traits in a community can provide insights into community assembly processes and ecosystem functioning. Functional diversity indices can be constructed from a single trait, such as body length, or from the combination of multiple traits, such as body length, hunting mode and habitat preference. However, the performance of these indices in explaining ecosystem functions remains largely unexplored. In this study, we used empirical data to examine which component of ground-dwelling predator community structure best explained predation rates of pests in cereal fields. Functional diversity indices explained a greater part of variation in predation rates than any other taxonomic or activity-density component. Among the indices for functional diversity, single-trait indices better predicted variation in aphid predation rates compared with multiple-trait indices. In particular, we found that the community-average value of body-size of ground-dwelling predators was negatively related to predation rates of aphids, whereas the proportion of spiders with a preference for arable land was positively related to predation rates. Additional analyses of body-size distributions of ground-dwelling predators suggested that intraguild predation was a key process shaping the relationship between predator community and the level of aphid pest control. Considering the functional trait composition of communities provides a more mechanistic understanding of the processes shaping the strength of trophic interactions in terrestrial ecosystems. These results will help the management of ecosystem services in agricultural landscapes.

P4 - Effects of land use intensity on grashopper and bumblebee communities on different spatial scales

Jörn Boller[1], Matthias Schindler[2]

[1]Universität Bonn, INRES - Tierökologie, 53127 Bonn, DE, jboller@uni-bonn.de
[2]Biologische Station Bonn/Rhein-Erft, 50374 Erftstadt, DE

The diversity and composition of grasshopper and bumblebee communities are dependent on functional traits, such as dietary and habitat specialization. Many grasshopper species depend on specific microclimatic conditions, which are influenced by the structure of vegetation. Bumblebees especially need suitable foraging sites in the close vicinity of their nests. For this reason, both taxa are strongly affected by land use intensity.

In 2013, 2014 and 2015 we conducted investigations on 24 grasslands in the Eifel and the Süderbergland (NRW, Germany). We studied three different grassland management regimes: Agri-Enviromental-Measure (AEM), Control-Group - without commitments (CTL), Contractual-Nature-Conservation (CNC).

The abundance of bumblebee and grasshopper species were recorded from April to October, along given transects. In addition, variables such as biotope types, land use intensity or flower density were quantified on the landscape scale.

The aim of this research project is to analyse the effects of grassland extensification on grasshoppers and bumblebees on different spatial scales. Therefore, we analyse the correlations between the landscape or habitat parameters and faunistic parameters, such as number of species, species activity, diversity and functional traits.

P5 - Importance of landscape crop heterogeneity for functional diversity of carabid and rove beetles

Aliette Bosem Baillod[1], Péter Batáry[1], Yann Clough[2], Teja Tscharntke[1]

[1]Agroecology, Georg-August University, Göttingen, DE, aliette.baillod@agr.uni-goettingen.de
[2]Centre for Environmental and Climate Research, Lund, SE

Increasing agricultural landscape heterogeneity through maintenance of semi-natural areas is often considered as a key to increase biodiversity. In simplified landscapes with high share of cultivated areas, it may be difficult to increase the heterogeneity without taking too much land out of production. Crop mosaics can also provide resources for many arthropods. In return, they can provide ecosystem services benefiting food production such as pest or weed seed predation. Hence, it is not only important to focus on the diversity of arthropods per se (i.e. taxonomic diversity), but on the functional diversity as well. Carabid and rove beetles are important providers of ecosystem services, since they cover a range of trophic levels (i.e. species have different dietary preferences). We investigated how the heterogeneity of cultivated areas in the landscape affects carabid and rove beetles in central Germany. Pitfall traps were used for sampling beetles in 32 simplified landscapes along uncorrelated gradients of crop diversity (crop types' Shannon index; i.e. landscape composition measure), amount of field edges (field perimeter; i.e. landscape configuration measure) and field margins (mainly uncultivated grassy strips along crop fields). Our results showed that the amount of field edges and field margins was more important than the landscape crop diversity for ground beetles. Landscape composition and configuration played a minor role for rove beetles. Simplified landscapes containing more field edges and margins increased the species richness of carnivorous and omnivorous ground beetles. Thus, increasing edge densities in agricultural landscapes could be relevant for the conservation of the predatory function of ground beetles.

END OF SESSION 44

Session 45 - Supportive data management tools for integrated ecological studies – best practices and smart services
Short title: Best practices & smart services in data management

CHAIRS: JULIANE STECKEL, CLAAS-THIDO PFAFF, MICHAEL OWONIBI

O1 - GFBio - improving data quality and availability in biological sciences

Juliane Steckel[1]

[1]Georg-August-University Göttingen, Dep. Research, Göttingen, DE, Juliane.Steckel@zentr.uni-goettingen.de

Ecologists are nowadays confronted with a data deluge on the one hand and scattered information on the other hand. Assessing quality of potentially useful data is an additional challenge. At the same time, research questions of today feature a wider, up to global context and involve highly diverse and big data, like genetic, ecological, environmental or collection data, to study climate change or ecosystem services. GFBio provides a coherent infrastructure to easily find high quality data of relevance, facilitates scientific data integration and allows for preservation.

GFBio is 'The German Federation for Biological Data' and builds on proven infrastructures and tools like PANGAEA (Data Publisher for Earth and Environmental Science), Bexis++ (Biodiversity Exploratory Information System), DWB (Diversity-Workbench) and SILVA (high quality ribosomal RNA databases). Important stakeholders in functional biodiversity and environmental science from 19 institutions within Germany work together to offer a central portal for added-value-services concerning data intensive research. These services will cover the whole data life cycle and integrate into the research cycle. They include easy-to-use tools e.g. to collect data, to assure their quality, to analyze and visualize datasets or to save and re-use data for the long term.

GFBio dynamically builds up a diverse training environment. We prepare e-modules, manuals, screencasts and videos to improve the awareness and the application literacy of researchers in the field of biological sciences, but also National History Collections as well as larger national and international research projects and institutions. GFBio explicitly addresses the long tail of science by involving individual researchers through pro-active outreach measurements. Finally, GFBio offers personal training at workshops during conferences and assemblies or on command.

O2 - Diversity GIS Editor - a GFBio compliant tool for processing geographical object information in biodiversity research and citizen science projects

Wolfgang Reichert[1], Markus Weiss[1], Wolfgang Ahlmer[1], Iris Leininger[1], Dagmar Triebel[1]

[1]IT Center of the Staatl. Naturwissenschaftliche Sammlungen Bayerns, München, DE, reichert@bsm.mwn.de

The Diversity GIS Editor is a tool to create, visualize, edit and archive samples within a geographical environment. It may be used as a component integrated in Diversity Workbench (DWB) client-server applications like DiversityCollection and DiversitySamplingPlots. DWB network installations for biodiversity data management are compliant to the GFBio infrastructure (““German Federation for Biological Data”).

Apart from this, the Diversity GIS Editor might be well used as a stand-alone application. In combination with a background map, equipped with world coordinates, collections of Microsoft SQL Geometry Objects (points, lines, areas) may be displayed and easily edited in their geographical context. Color, size, thickness and transparency of the elements can be adjusted. The working area which keeps the map and objects may be shifted or zoomed.

The background map could either be loaded from a storage device or created with an online map server tool provided by the editor. Other maps without coordinates may be georeferenced just by setting 3 pairs of reference points on the background and the new map.

The geographical objects could be stored and read with several data formats, e.g. tab separated text files or ArcGIS shape files. Tools are provided for measuring distances or digitizing sample markers from analog paper sheets. GPS functionality has been integrated. If a GPS device is connected, the current position will be displayed and – assumed an applicable background map is loaded – recorded on the map. The use is free of charge (download under http://diversityworkbench.net/Portal/DiversityGisEditor).

Because of its user-oriented functionality and ease of operation the Diversity GIS Editor is especially appropriate for biodiversity monitoring research and citizen science projects with restricted access to advanced institutional IT infrastructure. The Diversity GIS Editor is promoted for citizen science experts in the long-term initiative “Flora von Bayern”. In this context training material, digital maps and GIS shapes are offered. The service is done in cooperation with the Bavarian Environmental Agency, the Bayerische Vermessungsverwaltung and the WWF Deutschland.

O3 - Explorative Workflows for Data-Driven Geo-Science

Christian Authmann[1], Christian Beilschmidt[1], Johannes Drönner[1], Michael Mattig[1], Bernhard Seeger[1]

[1]University of Marburg, Marburg, DE

In the context of data-driven biodiversity research, scientists need a flexible and performant system for exploring and analyzing spatio-temporal data. We propose the Visualization, Aggregation and Transformation (VAT) system that provides web-based GIS functionality on top of a high performance processing backend. The development of this system is part of the two ongoing projects GFBio and Idessa. In

GFBio we will provide added-value services by integrating various kinds of data sources. Idessa, as a research project, serves as a concrete use case for processing and managing large spatio-temporal data.

In the VAT system workflows are the central concept for defining the steps of a computation. In contrast to traditional workflow approaches the system allows users to work in an explorative way. They start with a given data set, apply an operator, review the result and continue designing the workflow. This includes changing parameters and introducing new computational steps by adding operators and additional data sets. The system keeps track of the processing chain in form of a reusable and sharable workflow.

Our highly interactive approach is only viable when (intermediate) results are produced in a timely manner. This poses unique challenges when large data sets are involved, e.g. remote sensing data that can exceed hundreds of gigabytes. It is therefore crucial to minimize the data transfers among processing operators of workflows and to enable parallelism whenever possible.

A flexible usage of the system requires extensibility and interoperability. We thus allow the execution of scripts, e.g. written in R, as part of our workflows. The software will also be open-source and provide standardized interfaces, e.g. from the OGC, allowing other systems to access the results of computations. This enables the usage of our system as part of a larger workflow, where users can finish their final computation inside other environments.

O4 - A Semi-Automated Ecological Data Specific Learning Approach

Pawandeep Kaur[1]

[1]Friedrich-Schiller-Universität,Jena, Jena, DE, pawandeep.kaur@uni-jena.de

Ecological studies produce highly complex, heterogeneous and distributed data from its wider research activities. For efficiently communicating the research work and presentation of the related data, visualization plays an important role, due to its ability to condense large amounts of data into effective and understandable graphics. The decision of optimal choice of visualization, not only produces more interpretable graphics, but support the community to understand, analyse the data and reuse it for their respective studies. However, studies have shown that the potential of visualization has not been fully utilized in scientific journals, due to inappropriate visualization selection with respect to the nature of data and message to convey. This does not only impede analysis but also results in misleading conclusions. To provide a solution for the problem of visualization selection, we propose a semi-automated context-aware visualization recommendation model. In the model, information will be extracted from data and metadata, and annotated with suitable ecological operations (analytical tasks like spatial distribution, relative species abundance). This information will be mapped to the visualization semantics;

like in each extracted operation which variables are involved and how they are visually represented. This helps in deriving the relevant visualizations for that data. We also propose an interactive learning workflow for visualization recommendation that will enrich the model from the knowledge gathered from each interaction with the user. In our work, we will develop our base knowledge (which visualizations have been used to represent what ecological operations) from the visualization presented in the ecological publications. This knowledge is integral in making decisions based on the current trends in visualizations for representing ecological concepts and data.

O5 - Selecting, Tailoring and Aligning Formal Ontologies for Scientific Knowledge Management in the AquaDiva Project

Erik Fäßler[1], Friederike Klan[1], Alsayed Algergawy[1], Udo Hahn[1], Birgitta König-Ries[1]

[1]Friedrich-Schiller-University, Jena, DE

Current database management technology allows to store the ever-growing set of heterogeneous scientific data. However, due to the semantically non-uniform way (custom abbreviations, non-explicit relationships between data columns etc.) in which data is stored, the retrieval of relevant data for a given search query and the coherent integration into an easily human-understandable result remains a challenge. Our research addresses this issue by making the underlying meaning of scientific data machine-comprehensible and thus enables more accurate and comprehensive retrieval.

We represent the meaning of data in terms of formal knowledge representations (ontologies). The scientific framework we are working in, the SFB 1076 "AquaDiva", incorporates many different disciplines, such as biology, chemistry, physics and ecology. Accordingly, already existing ontologies in these areas have to be screened in order to construct a common knowledge base for a semantically informed management system for scientific data. We currently develop a tool suite which interactively supports the following ontology engineering steps:

- Selecting a minimal subset of relevant domain ontologies from BioPortal, the largest biomedical ontology repository, by matching domain terms delivered by scientists with the knowledge occurring in the portals' ontologies;

- Tailoring identified ontologies by finding 'minimal terminology coverings', i.e., we prune those portions of the selected relevant ontologies which contain - from the AquaDiva perspective - irrelevant knowledge; these compressed ontologies are smaller and thus computationally 'cheaper' to process for formal reasoning;

- Aligning these 'minimal' relevant ontologies to a single combined ontology; this combined ontology has to be checked for consistency (avoiding contradictory knowledge), specification gaps (avoiding incomplete knowledge), coherency (conceptual overlaps of the tailored ontologies).

O6 - KiLi central database: an infrastructure to innovate data intensive science

Jie Zhang[1], Ingolf Steffan-Dewenter[1]

[1]University of Würzburg, Würzburg, DE, jie.zhang@uni-wuerzburg.de

The complex nature of research questions in Ecology and environmental sciences requires interdisciplinary data from multiple spatial and temporal scales, where the biodiversity loss and global changes take place. The increasing availability of massive volumes of interdisciplinary data provides great potential on ecological research databases. It is no longer merely a media to store and query data, but also a model builder that provides synthetic analysis techniques to efficiently explore and identify interesting patterns that were otherwise not apparent.

The DFG funded KiLi project studies the Kilimanjaro ecosystems under global change, linking biodiversity, biotic interactions and biogeochemical ecosystem processes. In the second phase, a large amount of data from Kilimanjaro across many disciplines is already available in the KiLi central database. The KiLi central database, which was built on basis of BExIS platform, is developing efficient synthetic tools, such as error detection, data aggregation, data merging, statistical modelling, and spatial visualization, to support ecological data management throughout its life cycle. By interpreting these tools, scientists are able to analyze bigger and more complex synthetic systems efficiently, which complements the traditional processes of hypothesis-testing approach, and opens a new paradigm for data intensive science in biodiversity studies.

O7 - Data acquisition - start smart instead of work hard

Dirk Fleischer[1], Andreas Czerniak[1]

[1]Helmholtz-Centre for Ocean Research GEOMAR, Kiel, DE, dfleischer@geomar.de

Data capturing and data management is an isolated process in the scientific world. By choosing the point of time where a scientist writes or publishes an article as the right time to approach a scientist for data archiving leads to a gap between data creation and data archiving. The first hand knowledge on data creation is already lost due to the scientific procedures. Bringing digital data capturing to the point of hand written protocols and field sampling can bridge this gap. According to established field and lab traditions hand written protocols are still widely used. The KDMI performed several use cases with such a technology to evaluate its advantages and the acceptance in the scientific community.

O8 - Introducing Movebank: An animal movement database

Diego Ellis Soto[1,2]

[1]Max Planck Institute for Ornithology, Radolfzell, DE, Diego.Ellis-Soto@uni-konstanz.de
[2]University of Konstanz, Konstanz, DE, Diego.Ellis-Soto@uni-konstanz.de

Movements of free-ranging animals documented by sensors attached to individual animals are essential to movement ecology research. However, due to equipment costs and the logistical difficulty of data collection, animal tracking datasets often lack the sample sizes needed for robust statistical analysis or hypothesis testing. At the same time, datasets are quickly increasing in size as higher-resolution tags become available, posing data management challenges for many biologists. There is thus a need for tools to manage and share animal movement data to address movement ecology questions. Movebank (www.movebank.org) offers a free, online infrastructure for managing, sharing, analyzing, and archiving these data. It is open to all researchers, who retain full ownership of and control over access to their data. Live data feeds, a flexible system for importing files, and tools for managing deployment periods and other metadata allows researchers to create and manage their own studies. Users with access to data can apply filters, access it in R for analysis, and annotate environmental information from global remote sensing and weather data products using the Env-DATA System. To allow permanent public archiving, the Movebank Data Repository gives users the option to publish datasets associated with peer-reviewed papers and receive a DOI. With over 1,600 user-created studies, many accessible to the public, and over 162 million animal locations, Movebank offers unique opportunities for data sharing, outreach, and collaboration. We will illustrate how Movebank can be used in a movement ecology context using tracking data of Galapagos tortoises.

O9 - The TR32DB - a research data management system for soil, vegetation and atmosphere research data

Constanze Curdt[1,2], Dirk Hoffmeister[1], Georg Bareth[1], Ulrich Lang[2]

[1]Institute of Geography, University of Cologne, Cologne, DE, c.curdt@uni-koeln.de
[2]Regional Computing Centre (RRZK), University of Cologne, Cologne, DE, c.curdt@uni-koeln.de

In recent years, the importance of research data management (RDM) has increased. In particular, research data that were generated in collaborative, interdisciplinary research projects have to be stored, backed up and documented in a structured manner to enable exchange and re-use. This concerns particularly to research projects with a focus on environmental field studies and regional modelling in a spatio-temporal context. Thus, the establishment of a RDM system is essential.

This contribution presents the TR32DB (www.tr32db.de), a RDM system established within the DFG-funded (2007-2018) interdisciplinary, long-term Collaborative

Research Centre/ Transregio 32 (CRC/TR32) 'Patterns in Soil-Vegetation-Atmosphere-Systems: Monitoring, Modelling and Data Assimilation' (www.tr32.de). The TR32DB has operated online since early 2008 and manages all data created by the project participants. This includes heterogeneous research data (e.g. field measurement data, modelling results) in various spatio-temporal scales and from different disciplines (e.g. soil and plant science, hydrology, geography, geophysics, meteorology). In addition, further project related documents and information are handled (e.g. publications, presentations, reports or pictures).

The TR32DB is set-up in close cooperation with the Regional Computing Centre of the University of Cologne (RRZK). A three-tier architecture was designed and implemented applying available hardware and software components of the RRZK (e.g. data storage, database, web-interface). A multi-level TR32DB specific metadata schema was designed and implemented to enable the accurate, interoperable description of all data. Overall, the TR32DB supports common features of RDM systems including data storage, backup, exchange, publishing, search, provision of DOIs, and a WebGIS. The system was established according to the requirements of the DFG and the project participants (e.g. heterogeneous data in various file sizes).

O10 - TRY - a global database of plant traits: recent developments and future perspectives

Jens Kattge[1,2], Gerhard Bönisch[1], Sandra Diaz[3], Sandra Lavorel[4], Colin Prentice[5], Paul Leadley[6], Christian Wirth[7]

[1]Max Planck Institute for Biogeochemistry, Jena, DE, jkattge@bgc-jena.mpg.de
[2]German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig, DE, jkattge@bgc-jena.mpg.de
[3]CONICET - Universidad Nacional de Córdoba, Instituto Multidisciplinario de Biología Vegetal, Cordoba, AR
[4]Laboratoire d'Ecologie Alpine, Université Joseph Fourier, Grenoble, FR
[5]Imperial College, London, UK
[6]Laboratoire Ecologie Systématique Evolution, Université Paris Sud, Orsay, FR
[7]Special Botany and Functional Biodiversity, University of Leipzig, Leipzig, DE

The TRY initiative (www.try-db.org) is a community effort providing an unprecedented coverage of plant trait data. While TRY has started as a rather closed consortium, it has recently opened to the public. To improve data quality and interoperability, TRY promotes the development of an agreed vocabulary for plant traits. This presentation reports about these developments and future perspectives.

TRY has recently opened access and the major fraction of data has become public available. However, within TRY, the data remain property of contributors, who may restrict access to individual files. In parallel, we have established a digital repository for files related to plant traits, the TRY File Archive (www.try-db.org/TryWeb/Data.php). Providing digital object identifiers (DOI) makes each dataset citable.

Names and definitions of plant traits so far show only very little degree of consolidation. TRY therefore collaborates with the TOP initiative to establish a thesaurus for plant traits (http://top-thesaurus.org/). The TOP-Thesaurus is a joint development of experts from the plant biodiversity domain, computer science and information technology. In combination with the ongoing consolidation of plant trait data in the context of TRY, plant taxonomy (*www.theplantlist.org*)and species occurrence (*www.gbif.org*) we expect the TOP-Thesaurus to provide a long missing cornerstone towards improved interoperability for plant trait data in functional diversity research.

P1 - Towards a vocabulary to aid data annotation and discovery in ecology

Claas-Thido Pfaff[1], David Eichenberg[1], Mario Liebergesell[1], Birgitta König-Ries[2], Christian Wirth[1]

[1]Universität Leipzig, Leipzig, DE, claas-thido.pfaff@uni-leipzig.de
[2]Universität Jena, Jena, DE

Ecology is an inherently cross-disciplinary science that has grown into a highly collaborative and data intensive science over the last decade. Driven by technological advances new data is generated at an increasing pace across all ecological disciplines. While many of the data in ecology is uniform we also face high heterogeneity introduced by manually acquired data. This is reflected in the variety of study systems, methods, data types, environmental contexts and in temporal and spatial scales and resolutions. With an increasing amount of environmental data getting available online through scientific platforms and networks the data potentially can be reused in a wider context. One specific reuse is the fusion of many datasets in meta-analyses. This is of particular interest in ecology as it potentially allows quantitative summaries to generate higher-order conclusions about general trends and patterns. Keyword based full text search mechanisms are widely spread, however this type of search is known to return many false positive results. They are ignorant with regards to closely related terms, synonyms or the overall semantic context of a search. Thus finding data suitable for a certain research idea is not trivial and filtering for relevant data through a plethora of results is a time consuming and manual task. We here introduce a vocabulary designed to be used as framework to guide data annotation and discovery of ecological datasets. It is specifically tailored to fit the semantics of ecological research. The main design principles of the vocabulary are simplicity, good coverage of important concepts in ecology and compatibility with existing, vocabularies. These design principles allow for a fast manual data annotation. Further more it can be used for an improved data discovery in a faceted search approach that significantly reduces the amount of ecological data to manually scan through. The annotation with concepts from a controlled vocabulary also represents a big step towards more semantically aware search mechanisms based on ontologies that might be used in the future.

P2 - Closing the Gaps in Biodiversity Data Management: What Biodiversity Researchers Seek and Computer Science Can Offer

Friederike Klan[1], Felicitas Löffler[1], Jitendra Gaikwad[1,2], Roman Gerlach[3], Alsayed Algergawy[1], Dorothee Wieczorek[1]

[1]Friedrich-Schiller-University, Institute for Computer Science, Jena, DE
[2]German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig, Leipzig, DE
[3]Friedrich-Schiller-University, Institute for Geography, Jena, DE

Recent progress in computer science and emerging technologies has contributed to a paradigm shift in the way biodiversity and ecosystem research is conducted. Access to a plethora of data is enabling scientists to carry out data-intensive research. Both, computer and biodiversity science domains can profoundly benefit from these developments. Research in biodiversity sciences is facilitated and expedited by a wide spectrum of innovative tools available for data management, visualization, publishing, discovery, analysis, storage, accessing and sharing. New challenging requirements in biodiversity science are leading to interesting research topics in computer science that advance the field of both disciplines. However, we observed during our work in the BExIS2, iDiv, GFBio and AquaDiva projects, which are committed to data management for biodiversity research, that although essential, new tools and technologies from computer science are hesitatingly accepted by the biodiversity community. On the other hand, computer scientists are often unaware of real requirements by biodiversity researchers. Thus, the full potential of the partnership between the two disciplines is not achieved. With our involvement in various activities such as workshops, teaching, trainings or user studies, we seek to close the gap between the two fields. In this contribution, we share our findings about the main hurdles that hamper the adoption of existing software for data management and identify potential strategies to overcome these. We also provide a roadmap for reducing the gaps between the researcher's data management requirements and the tools developed by computer scientists. We are also seeking active participation from biodiversity community and encourage researchers to provide feedback about how well their data management needs are served.

P3 - Vegetation plot data is a key to ecology

Florian Jansen[1], Ute Jandt[2]

[1]Ernst-Moritz Arndt University, Greifswald, DE, jansen@uni-greifswald.de
[2]Martin-Luther-University, Halle-Wittenberg, DE

Since more than 100 years vegetation scientists have used the simple method of writing down lists of all plant species occurring together in a defined small place, normally with an indication of performance (e.g. proportional cover) and height class. Potential exploitations of these invaluable biodiversity data range from local site assessment, to exploring assembly rules, analysing temporal changes, to mac-

roecological pattern analyses. The talk will present the platform http://www.veget web. deas a nationwide repository for vegetation plot data in Germany, covering hundreds of thousands of individual vegetation plots. The vegetweb platform aims to give a transparent access to the majority of vegetation plot data in Germany, to provide proper data rights for data owners, and to make vegetation plot data citable for publication and repeated analysis. Data of individual projects can be assigned to three access levels "open access", "restricted access", and "blocked data". All data enquirer have to fill out a request form containing their research aim, an optional offer to data owners (e.g. potential co-authorship), and the data selection filter. For open access data access will be granted immediately, blocked data cannot be offered, and for restricted data the respective data owners will automatically be asked to give access permission. A data basket, containing the selection, enquirer id, the request form, and the agreed access rights to the selected plot data, will be presented on the platform. Every data basket has a unique resource identifier (URI) to give direct access to the data (given the correct credentials), and to make the data citable. We hope that this solution for data sharing and re-using will successfully attract potential data donors and will be a prototype for other applications and for international cooperation.

P4 - Novel tools to support integration and processing of spatially explicit data for ecological modelling

Christian Krippes[1], Birgit Aue[1], Volkmar Wolters[1]

[1]Department of Animal Ecology Justus-Liebig University, Giessen, DE, Christian.Krippes@bio.uni-giessen.de

Assessing the impact of economic activities on ecosystems with field surveys is costly and cannot sufficiently capture species and habitats at broader scales. The project ÖkoService develops an innovative approach for using existing data in ecological models to make them applicable for urban and landscape planning. Particularly, ÖkoService provides software modules to facilitate the integration of collated data and the use of species distribution models in an applied context. The implementation is realized as a client-server solution based on open source components (e.g. QGIS and POSTGIS / PostgreSQL).

Since spatially explicit data become increasingly popular in ecology, the conceptual approach of ÖkoService might also provide a starting point for solutions for data storage, documentation and integration.

Here we present the software concept and the yet implemented modules which allows for (1) creating land-use maps from integrated data sources which takes the perspective of the species under consideration, (2) rapidly calculating landscape metrics for including them into the models, and (3) easily creating stochastic and knowledge-based species distribution models.

P5 - Shiny helps NaLaMa to sparkle

Robert Nuske[1]

[1]NW-FVA, Göttingen, DE, robert.nuske@nw-fva.de

The joint project **NaLaMa (http://www.nalama-nt.de/)** developed a knowledge and decision basis for a sustainable land management in the North German Plain against the background of climate change and increasingly globalized markets. 21 partner studied the main land use systems (forestry, agriculture and water management) and their interactions using statistical and process models. A scenario analysis (business as usual, biodiversity and climate mitigation) covering four model regions and the period from 1991 to 2070. A trans-sectoral indicator system was used to compile the numerous simulation results. Technically the results were sanitized and managed using R which has become the lingua franca of data science and especially popular in ecology. The collected numbers were stored in a central database. The project partners were enabled to check the imported data via an online tool. The R package **shiny** helped to easily bridge the gap between a local R session and the internet. An interactive web application could be built with only a few lines of R-code. Automatic reactive binding between inputs and outputs and pre-built widgets simplified the creation of beautiful, responsive, and powerful applications. The resulting web application can be run on any Linux server via shiny server requiring only basic R.

A shiny-app bundled the feedback from the central database for the NaLaMa-partners in form of water level reports, filterable tables, and visual plausibility checks. Our experience with building the shiny-app to provide immediate feedback to the partners and the user uptake will be discussed.

P6 - Diversity Workbench network installations at a GFBio Collection Data Center

Tanja Weibulat[1], Anton Link[1], Dieter Neubacher[1], Wolfgang Reichert[1], Stefan Seifert[1], Markus Weiss[1], Dagmar Triebel[1]

[1]SNSB IT Center, Munich, DE, weibulat@bsm.mwn.de

The Diversity Workbench (DWB) is a virtual research environment and platform for the management, curation, quality control and analysis of data in biodiversity, ecological and environmental research. The DWB framework includes a set of Microsoft SQL Server databases and tools for data import, editing, maintenance and storage as well as data export. It provides a sophisticated user right management and history control. The DWB source code is available under the GPL v. 2.0 license. The code repository, documentations, manuals and a download center are accessible under www.diversityworkbench.net. An application for smartphones designed for biologists monitoring data in the field is available (www.diversitymobile.net). Installations of the system may be run locally or by remote database access achieved via internet. The DWB network installation at the SNSB IT Center serves more than 50 projects with around 150 users.

The interoperability, flexibility and scalability are the result of a conceptual design relying on data domains addressing content areas (e.g. collection and observation data, sampling plots, trait data, terminologies, taxonomies etc.). Each of the12 modules may be installed as a stand-alone application or interlinked by external identifiers (URIs) with one or more of the other 11 modules, without knowing about the internal design. This makes the management system appropriate for individual researchers, for research groups and for large research projects as well as institutional data centers as the so-called Collection Data Centers of the 'German Federation for Biological Data (GFBio)'.

Currently there are three GFBio Collection Data Centers with their own DWB network installations. They all have access to freely available content services. Additional RESTful web services supplement the offer. The installations are part of the curatorial and archival backbone and sustainable infrastructure of GFBio. Each DWB network installation facilitates the processing of highly structured research data starting with the ingestion as well as management, preservation and dissemination for access and publication.

P7 - The Freshwater Information Platform - a new online network supporting freshwater biodiversity research

Vanessa Bremerich[1], Astrid Schmidt-Kloiber[2], Aaike De Wever[3]

[1]Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, DE, bremerich@igb-berlin.de
[2]University of Natural Resources and Life Sciences, Institute of Hydrobiology and Aquatic Ecosystem Management (BOKU), Vienna, AT
[3]Royal Belgian Institute of Natural Sciences (RBINS), Brussels, BE

Species distribution data is crucial for improving our understanding of biodiversity and its threats. This is especially the case for freshwater environments, which are heavily affected by the global biodiversity crisis. Currently, a huge body of data gathered by scientists and water managers is often difficult to access and use because systematic data publishing practices have not yet been fully adopted and data embedded in scientific papers and research project websites are often challenging to extract.

The key goal of the EU funded FP7 project BioFresh (2010-2014) [1] was to improve the capacity to protect and manage freshwater biodiversity in the face of global change through mobilising freshwater biodiversity datasets, making them available through an online information platform and integrating them in large-scale models and tools. The Freshwater Biodiversity Data Portal [2] component of this platform assists data holders in publishing their datasets in its occurrence database through a BioFresh installation of GBIF's Integrated Publishing Toolkit and links the imported occurrence data to a central taxonomic backbone (the FADA database [3]). To further encourage detailed characterisation and documentation of datasets as well as open access publication an automated workflow was developed for publishing entries of the Freshwater Metadatabase as an article in the recently launched Freshwater Metadata Journal [4]. The use of collected datasets for large-scale analyses and models is demonstrated in the Global Freshwater Biodiversity Atlas [5] that publishes interactive online maps featuring research results on freshwater biodiversity, resources, threats and conservation priorities.

To continue the mission of the BioFresh information platform after the end of the project, four European research institutes in Austria, Belgium and Germany have joined forces and built the Freshwater Information Platform [6], integrating results and data from finished, ongoing, and future freshwater research projects. In addition to the Freshwater Biodiversity Data Portal and Atlas, it features among others the Freshwater Species Traits Database [7], the Freshwater Blog [8], and sections on research resources, tools and networks. All sections are composed as 'living documents' that will be continuously improved and updated.

[1] http://project.freshwaterbiodiversity.eu/
[2] http://data.freshwaterbiodiversity.eu/
[3] http://fada.biodiversity.be
[4] http://freshwaterjournal.eu/
[5] http://atlas.freshwaterbiodiversity.eu/
[6] http://www.freshwaterplatform.eu/
[7] http://www.freshwaterecology.info
[8] http://freshwaterblog.net

END OF SESSION 45

Session 46 - The role of microbes in ecology

CHAIRS: DANIEL S. ESSER, BASTIAN STEUDEL, MITJA N. P. REMUS-EMSERMANN, TATYANA DARIENKO

O1 - Microbial ecology across spatial scales

Daniel S. Esser[1], Mitja N. P. Remus-Emsermann[2]

[1]University of Goettingen, Göttingen, DE, desser@uni-goettingen.de
[2]Federal Department of Economic Affairs, Institute for Food Sciences IFS, Wädenswil, CH

Microbes provide valuable services to ecosystems and affect ecosystem stability by pathogenic or mutualistic interactions with macro-organisms or one another. While some of these ecosystem services such as nitrification/ denitrification, recycling of organic materials, and pathogenicity are commonly investigated at large ecological scales, the role of microbial diversity and microbial interactions for the ecosystem often remains unclear.

Using plant leaf surface colonizing bacteria as an exemplary test case, we will illuminate how the analysis of spatial distribution patterns of bacteria can be used for an improved understanding of microbial ecology and the impact of those bacteria on their plant host. The observed spatial patterning can be used for environmental modelling and provide explanations for complex or unexpected microbial activities.

Such bottom-up, rather than top-down, descriptions of microbial community compositions and structure shed light on the complex interactions of microbes in their habitat even under changing environmental conditions or along gradients. This knowledge will prove crucial for explaining microbe-mediated phenomena on larger scales, e.g. the scale of individual host plants, plantcommunities, or even at the scale of whole ecosystems. We argue that this is also the case for other microbial habitats such as soil, aquatic systems, insects, or mammal associated microbial communities. In conclusion, we believe that multi-scale studies of microbial processes and interactions will enable novel avenues to understand, manage, and improve ecosystem functioning.

O2 - Tree-microbial biomass competition for nitrogen, phosphorus and potassium in a temperate deciduous forest

Marcus Schmidt[1], Edzo Veldkamp[1], Marife D. Corre[1]

[1]Buesgen Institute - Soil Science of Tropical and Subtropical Ecosystems, Georg-August University of Goettingen, Goettingen, DE, marcus.schmidt@forst.uni-goettingen.de

Competition between microbial biomass and plants has been shown for nitrogen (N) in grasslands, crops and beech trees as well as for phosphorus (P) in tropical peatlands. In an unmanaged temperate deciduous forest, both P and potassium (K) have previously been shown to limit the growth in stands of beech, but not in oak, hornbeam or lime. Our present study was aimed to determine whether there is competition for nutrients (N, P and K) between microbial biomass and trees. We selected stands of 4 - 8 trees containing beech, oak, hornbeam and lime as mono-species stands and mixed species stands of three of these species. To calculate nutrient resorption efficiency, we measured N, P and K concentrations in sun-exposed leaves in July 2013 and in leaf litterfall in the autumn of 2012. Annual net nutrient change during leaf litter decomposition, measured by in-situ litterbag incubation for 1.75 years (November 2011 - July 2013), was calculated as the difference between the initial nutrient contents in leaf litter and the remaining nutrient contents in the decomposed leaf litter after one year. Both beech leaf litter incubated in beech stands and oak leaf litter incubated in oak stands showed net immobilization of N and P, while hornbeam and lime incubated in their stands showed net mineralization for all measured nutrients. We found that N, P and K resorption efficiencies of tree species across stands were highest where net N, P and K immobilization occurred ($P \leq 0.01$). While net nutrient change in decomposing leaf litter influenced the availability of P and K in the soil, this was not the case for soil N availability. The resorption efficiency of trees for N was influenced by the net nutrient change in decomposing leaf litter, although not as strongly as P and K resorption efficiencies. We conclude that competition between microbial biomass and trees was strong for P and K and minor for N, likely due to high atmospheric N deposition in this forest ecosystem.

O3 - Does leaf litter diversity affect soil microbial community structure and functions in Chinese subtropical forest?

Zhiqin Pei[1], Katrin Seidelmann[2], Buscot François[1], Jessica Gutknecht[3]

[1]Helmholtz Centre for Environmental Research GmbH - UFZ, Halle Saale, DE, zhiqin.pei@ufz.de
[2]Institut für Biologie/Geobotanik , Albert-Ludwigs-Universität Freiburg, Freiburg, DE
[3]Department of Soil, Water, and Climate, University of Minnesota, Twin Cities, US

Plant litter diversity effects on decomposition and nutrient cycling are well reported in temperate ecosystems, but few studies have investigated the ecosystem functions altered by changes of litter diversity in highly diverse subtropical forests. The objective of this research was to determine microbial composition and functions in response to litter diversity during decomposition in a Chinese subtropical forest. Litter from seven local tree species, combined into two overlapping species pools, and were used to create replicates of three levels of litter diversity (1, 2, and 4 species mixtures). Dried litter for each species mixture was added into 10 mesocosms per treatment and replicated once in each of four corresponding blocks. Soil samples were taken at four time-points to correspond with litter sampling dates, 21, 49, 105, and 168 days after the plot establishment. At each sampling date, two of the 10 mesocosms were randomly chosen in each block for destructive harvest. Microbial community composition (lipid analysis) was observed at the third time point and the microbial functions (N mineralization and extracellular enzyme activities) were measured at each time point. Our results indicate the litter diversity only affected microbial community structure,as a result of substrate heterogeneity and microbial habitat diversity provided by the litter species mixture. In conclusion, litter diversity only affected microbial community structure, but there were positive relationships between microbial structure and functions. In addition, lignolytic enzymes are more sensitive to the microbial community shift than the cellulose degrading enzymes.

O4 - Tritagonists, not commensals: Microbes with unknown functions, but broad potential in agriculture and medicine

Florian Freimoser[1], Cosima Pelludat[1], Mitja, N. P. Remus-Emsermann[1]

[1]Agroscope, Wädenswil, CH, florian.freimoser@agroscope.admin.ch

Uncharacterized microorganisms are often labelled as commensals, even though it seems unlikely that true commensal microorganisms exist. To emphasize the functions of such microorganisms, we suggest the term tritagonist. The mostly sequence-based knowledge about the microbial species composition of various habitats is in stark contrast with the sparse factual information about biological roles of these organisms. In most cases, biological functions of the majority of species are unknown. The tritagonist concept implies biologically relevant, but yet uncharacterised functions of an organism, whilst at the same time leaving room for the exact nature of these functions.

Tritagonists exert their biological functions by interactions with other microbes or indirectly via the environment. Thereby, tritagonists regulate fitness, biological activities, and interactions of other species. Both, in agriculture and medicine, individual strains or communities of tritagonists are used against diseases or to establish a beneficial microbiome. However, only few tritagonists are known to induce new functions in an interacting organism (e.g., the production of an antibiotic or toxin) and the potential tritagonistic functions of most microbes are unknown. It is the goal of our research on soil fungi to identify and characterize tritagonistic yeasts. We perform competition and fitness profiling experiments in order to identify promising species for novel applications in agriculture.

In summary, studying environmental microorganisms as tritagonists extends oversimplified binary interactions (e.g., host-pathogen or pathogen-antagonist interactions) and may thereby identify novel key players that determine the fitness of pathogens. Identifying and characterizing tritagonists is thus the foundation for the development of novel applications to improve sustainability, productivity, and safety of agriculture.

P1 - Beech performance and nitrogen uptake in response to soil fungal inoculation

Dung Nguyen Quang[1]

[1]Dung Nguyen Quang, Göttingen, DE, dung.nguyen-quang@forst.uni-goettingen.de
[2]Silke Ammerschubert, Göttingen, DE
[3]Rodica Pena, Göttingen, DE
[4]Andrea Polle, Göttingen, DE

Soil fungal communities, especially ectomycorrhizal fungi (EMF), play an important role in plant physiology and ecology. We hypothesized that soil containing an active fungal community stimulates performance of *Fagus sylvatica* (beech) compared to soil without fungi and that soil fungi affect positively plant N uptake. To test these hypotheses, a greenhouse experiment was established using beech progenies from three different areas: Schorfheide, Hainich and Schwäbische Alb. Original forest soil collected in Hainich (F soil) was sterilized by ɣ-radiation and reinoculated with soil bacteria (N soil). F and N soils were used to grow beech progenies in the experiment. During the last three days before harvest, ^{15}N was applied using either $K^{15}NO_3$ or $^{15}NH_4Cl$. After two years of exposure, although there was no difference in EMF colonization rate between F soil and N soil, higher EMF diversity in F soil than in N soil was observed. Soil fungal communities improved performance of beech progenies. In F soil, significant differences in biomass were detected among beech progenies from different areas. Seedlings in Hainich F soil exhibited the highest fresh mass. Data on ^{15}N uptake to understand the N flux in beech will be presented.

Key words: *Fagus sylvatica*, soil fungi, ectomycorrhizal fungi and ^{15}N labeling

P2 - Multiple elements limitation to biological nitrogen fixation in a post-volcanic chronosequence

Cecilia Pérez[1], Frank Thomas[2], Wladimir Silva[1], Rodrigo Aguilera[1], Juan Armesto[1,3]

[1]Institute of Ecology and Biodiversity, Santiago, CL
[2]Universität Trier, Trier, DE
[3]Universidad Católica de Chile, Santiago, CL

A vast number of the studies on nutrient limitation to biological nitrogen fixation (BNF) in natural ecosystems are conducted in tropical forests, however scant on their temperate counterparts. These studies describe that the main elements that control BNF is phosphorous (P) in P poor soils and/or Mo (molybdenum) when P becomes more abundant, in particular in heterotrophic diazotrophs. However much less is known about the controls of BNF in temperate ecosystems, either free living and symbiotic in cryptogamic flora. Answer to this question is critical to understand how ecosystems recover after catastrophic disturbances, when biogenic elements are exhausted. The main objective of this work was to assess the main elements that control BNF along ecosystem development in three successional

stages: progressive, maximal and retrogressive, in a post-volcanic chronosequence in south-central Chile. BNF was assessed by measuring the acetylene reduction activity under different nutrient additions of Mo, P, C, (alone and in combination) and N in litter and cryptogamic carpets covering the soils and as epiphytes, in samples taken during autumn, winter and spring, during two consecutive years in field and laboratory experiments. Results show that the younger soil with the lowest total contents of C, P and Mo presented the lowest rates of both symbiotic and free-living BNF, however the addition of C+P+Mo all together significantly stimulated free living diazotrophs either in the younger or older soils during the colder and wetter winter season. We observed the same positive effect when adding all elements together for symbiotic diazotrophs in laboratory incubations in the spring in the younger soils and in winter in the mid phase. A significantly negative effect exerted the addition of N in all seasons in symbiotic diazotrophs during the mid and water a positive effect in all stages during the drier spring season. We conclude that the combination of limiting elements is mainly controlling BNF in both free living and symbiotic diazotrophs; its limitation is highly dynamic according to season and long term lasting along with ecosystem development. Fondecyt 1130353

P3 - Assessing Plant Pathogen Infection Rates in Natural Soils

Björn C. Rall[1,2,3], Ellen Latz[1,2,4]

[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE, bjoern.rall@idiv.de
[2]Institute of Ecology, Friedrich Schiller University Jena, Jena, DE, bjoern.rall@idiv.de
[3]Department of Aquatic Ecology & Department of Terrestrial Ecology, Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, NL, bjoern.rall@idiv.de
[4]J.F. Blumenbach Institute of Zoology and Anthropology, Georg-August-University Göttingen, Göttingen, DE

Pathogen infection assays are a standard method for estimating plant resistance to a specific pathogen. In natural soils, however, alternative pathogens might also simultaneously infect plants of the experiment hindering the estimation of the focal pathogen‘s infection rate. Here we present a method in R correcting for these unwanted effects by developing a two pathogen monomolecular infection model. We fit the model to data using an integrative approach by combining a numerical simulation of the two pathogen monomolecular infection model and an iterative maximum likelihood fit. Our method will be particularly useful for exploring resistance of natural soils (e.g. biodiversity experiments) from different sites because it allows for different naturally occurring pathogens while estimating comparable infection parameters.

P4 - Confining commensals - Tritagonist as a new term for uncharacterized microorganisms in environmental systems

Florian M Freimoser[1], Cosima Pelludat[1], Mitja Remus-Emsermann[1]

[1]Agroscope, Wädenswil, CH

In ecology, the term ‚commensalism‘ defines a one way relationship between two organisms, where one, the commensal, benefits without affecting the other. Originally, the term was used in a host-centric view for interactions where a ‚small‘ species (e.g. a microorganism) is provided with a habitat (e.g., skin) or waste products (e.g., methanol released by plants during their cell wall metabolism) as food by another, usually much larger host (e.g., a mammal or a plant). However, the term commensal has now started to rather imply an unknown, benign function than a truly proven commensal or antagonistic lifestyle. In particular when considering interactions among microorganisms, it seems unlikely that a true commensal microorganism exists. It may thus be prudent to assume a function for any kind of microorganism and to reserve commensal for organisms that have been shown not to influence their interaction partner. To emphasise such a microbe-centric view and to imply functionality, we suggest the term "tritagonist".

The ecological concept of the tritagonist is meant to promote a better understanding of natural systems. In research, it implies the need to extend oversimplified binary interactions (e.g., host-pathogen and pathogen-antagonist pairs) by including additional interaction partners, tritagonists, to obtain a more realistic view of microbial systems. We advocate the term tritagonist in particular with regard to the recent sequencing efforts in microbiome research, which have revealed a plethora of uncharacterised species and thus laid the foundation to link the evolutionary and genetic diversity with biological functions. We propose the tritagonist concept to define species with uncharacterised ecological functions in order to incentivise research on these organisms. The term implies biologically relevant, but yet uncharacterised functions of an organism or groups of organisms, whilst at the same time leaving room for the exact nature of these functions.

END OF SESSION 46

Session 47 - Conservation

CHAIRS: WOLFGANG W. WEISSER, TIM DIEKÖTTER, MARTIN ENTLING

O1 - Ecological Rewilding - Opportunities and challenges for a new approach to restoration

Henrique Miguel Pereira[1,2]

[1]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE, hpereira@idiv.de
[2]Institute of Biology, Martin Luther University Halle-Wittenberg, Halle-Wittenberg, DE, hpereira@idiv.de

Over the last few decades, landscapes in Europe have undergone major changes as people moved from rural areas to urban centers, marginal lands were abandoned and fertile soils were intensified. While, agricultural intensification has caused biodiversity declines in many places, farmland abandonment has opened the opportunity for biodiversity restoration elsewhere. But this is a controversial topic. Some conservationists see farmland abandonment has a major threat and something that should be stopped or even reverted. Others, have embraced the concept of rewilding abandoned landscapes and potentiating the return of biodiversity associated with forest and late successional stages, including some of the continent's megafauna. Here I discuss the concept of ecological rewilding. Ecological rewilding is distinct from other approaches to rewilding in that it does not uses a specific baseline to which ecosystems should be restored. Instead, ecological rewilding is about decreasing the human control of landscapes and promoting natural ecosystem processes. I discuss the main opportunities and on-going initiatives on rewilding and present some of the main challenges. I conclude with a discussion on how the CAP subsidies could be reformed to promote rewilding.

O2 - A new era for conservation science

Fabio Rubio Scarano[1]

[1]Brazilian Foundation for Sustainable Development (FBDS) and Federal University of Rio de Janeiro (UFRJ), Rio de Janeiro, BR, fscarano@fbds.org.br

Biodiversity conservation is a powerful discipline within biological sciences and has strongly influenced conservation policies across the planet. Protected areas, ecological corridors, species redlists, and ultimately the United Nations Convention on Biological Diversity are all policy tools that derived and still benefit from a strong conservation science background. However - despite undisputable success of conservation science - species extinction and greenhouse gas emission break new records every year and food and water security are at stake. The current planetary crisis seems to be common sense to policy makers and society as a whole, which results in an ambitious post-2015 sustainable development agenda in the making and

that reveals a strong sense of urgency. In this new scenario, traditional conservation science faces new challenges, some criticism and even competition. "New conservation science" and "postmodern conservation" are new trends or labels that start from the premise that traditional conservation science is either flawed or limited in positively influencing policy-making. "Sustainability science" and "land change science" are alternative or complementary transdisciplinary approaches that are policy-driven and attempt to balance environmental issues with socio-economic aspects. This paper 1) compares these different trends and practices and finds differences that range from ideology to methodology, but also similarities particularly in the overall shortage of empirical data and causal relationship analyses; and 2) discusses examples of cases in Brazil and elsewhere in which traditional conservation science positively or negatively influenced decision-making, while examining certainty requirements of policy-makers vs. scientists.

O3 - Prioritizing species for nature conservation in dynamic environments

Jan Christian Habel[1]

[1]Technical University Munich, Freising, DE, Janchristianhabel@gmx.de

Species conservation is mostly restricted to isolated conservation areas, a specific successional stage of an ecosystem, or to selected local populations of species or taxonomic groups. This strategy, as well as the selected species listed in the appendices of the European Habitat Directive as well as in various Red Lists has to be requested critically. When selecting species for conservation management, we have to consider its biogeographical history as well as its recent distribution situation. Relict species, persisting in small and isolated remnant populations over Central Europe (mostly at their western distribution margin) should have rather little relevance for nature conservation programmes. Furthermore, populations protected in small and isolated areas are expected to be conserved only for a short term, however, might suffer and become extinct due to large-scale, long-term environmental changes, as indicated in various studies. This contribution will highlight the challenge of (i) how to prioritize `relevant´ species for nature conservation and (ii) critically request the in-situ protection in small and isolated conservation areas in a highly dynamic environment.

O4 - Nature conservation in rural areas of developing countries - an example from Lake Alaotra, Madagascar

Jasmin Mantilla-Contreras[1], Pina Lammers[1], Tsiry Rakotoarisoa[1], Nora Schmidt[1], Maren Lux[1], Torsten Richter[1]

[1]University of Hildesheim, Institute of Biology and Chemistry, WG Ecology and Environmental Education, Hildesheim, DE, mantilla@uni-hildesheim.de

A major part of biodiversity is dedicated to developing countries in the tropics. This is a big challenge for conservation as human needs and political problems often hinder nature conservation. Madagascar belongs to the worldwide hotspots for biodiversity but is at the same time one of the poorest countries. Lake Alaotra is Madagascar's biggest fresh water lake supporting several locally endemic species. Conservation in the area is difficult due to thriving poverty and human population increasing drastically over the last decades. This has led to a dramatic loss of the naturally occurring flora and fauna and to degradation of the lake itself (e.g. lake shrinkage, hypoxia). Our project analyzed the impacts of human activities and invasive species (such as the water hyacinth) on the lake and its wetlands. In addition, we investigated effective conservation methods and alternative local sources of income suitable for the region. Hereby, we mainly focused on the use of the water hyacinth as a new source of fertilizer and raw material for handicrafts. Our results show that the conservation of even very small areas can currently be enough to successfully save endangered species such as the locally endemic Alaotran Bamboo Lemur. However, bigger areas would be needed in the future to avoid the decrease of species genetic pools. The use of the water hyacinth seems to be a very promising possibility to reduce the impacts of the plant on the lake ecosystems and to provide alternative fertilizer and income for the local people. Producing different fertilizer out of the water hyacinth is locally feasible and their application led to a higher biomass production in comparison to the commonly used chemical and expensive fertilizer (tested in a growth experiment with local crop species). In addition, the produced water hyacinth handicrafts suit to expectations of town based retailers and customers. This encourages the use of this plant as new local source of income. .However, as in all cases of conservation projects capabilities improvements and deep involvement of the local community are main factors assuring the success of such projects.

O5 - Human-carnivore conflicts can be associated with diseases of domestic animals and climate change: a case study from Iran

Igor Khorozyan[1], Mahmood Soofi[1], Arash Ghoddousi[1], Amirhossein Khaleghi Hamidi[2], Matthias Waltert[1]

[1]Workgroup on Endangered Species, Georg-August University of Göttingen, Göttingen, DE, igor.khorozyan@biologie.uni-goettingen.de
[2]Persian Wildlife Heritage Foundation, Tehran, IR

Human-carnivore conflicts challenge biodiversity conservation and local livelihoods, but the role of diseases of domestic animals and climate in such conflicts is poorly understood. We analyzed empirical data from all 34 villages around Golestan National Park (Iran) on the relationships between the probabilities of human-leopard (*Panthera pardus*) conflicts and diseases of domestic animals. Then, we applied the multi-model approach (generalized linear modeling GLM, Multivariate Adaptive Regression Splines MARS, Bayesian Belief Network BBN, BIOCLIM and DOMAIN) to explore the climate-diseases-conflicts system. We found that the more villagers were dissatisfied with veterinary services, the more likely they were to lose live-stock and dogs to leopard predation. Dissatisfaction occurred when vaccination crews failed to visit villages at all or, in most cases, arrived too late to prevent dis-eases from spreading. We suggest that increased morbidity of livestock makes them particularly vulnerable to leopard attacks. Moreover, conflicts and dog killing were higher in villages located closer to the boundaries of the protected area than in distant villages. In its turn, lower continentality and higher humidity (precipita-tion) patterns led to higher occurrence of diseases. As the Community Climate Sys-tem Model (CCSM4) scenarios forecast aridization of the study area in 2041-2080, they also predict a resultant decline of disease and conflict probabilities by 18.4-21.4% and 10.4-11.9%, respectively, in the same time frame. We appeal for im-proved enforcement and coordination of veterinary services in our study area, and propose several priority research topics such as veterinarian studies, role of wild prey in diseases of domestic animals, and further analysis of potential conflict pre-dictors. We also conclude that diseases can drive human-carnivore conflicts which may become less intense with projected aridization of the humid environment.

O6 - A nose for death: Integrating trophic and informational networks for conser-vation and management

Menna E. Jones[1], Raimund Apfelbach[2], Peter B. Banks[3], Elissa Cameron[1], Chris R. Dickman[3], Anke S. K. Frank[1], Stuart McLean[4], Iain McGregor[5], Dietland Müller-Schwarze[6], Michael Parsons[7], Elisa Sparrow[8], Daniel T. Blumstein[9]

[1]University of Tasmania, School of Biological Sciences, Hobart TAS 7005, AU
[2]Universität Tübingen, Tübingen, DE
[3]University of Sydney, School of Biological Sciences, Sydney, AU
[4]University of Tasmania, Division of Pharmacy, School of Medicine, Hobart, AU
[5]University of Sydney, Dept. Psychology, Sydney, AU
[6]State University New York, New York, US
[7]Columbia University, New York, US
[8]Parks, South Australia, AU
[9]University of California, Department of Ecology and Evolutionary Biology, Los Angeles, US

Management of wildlife using non-lethal means is becoming increasingly im-portant, and can be achieved potentially by modifying the behaviour of target spe-cies. The approach works by manipulating the cost-benefit relationships used by individuals to decide which habitat patches to visit and what to do once there, in particular how long to stay and whether to forage. For prey species—especially mammals, which are most often problematic for managers—there is considerable interest in applying predator odours to manipulate these decisions, but not all at-tempts succeed. The behaviour-modification approach assumes implicitly that ma-nipulations only have direct consequences; it ignores indirect effects that potential-ly could account for previous management failures. Here, we propose a novel food web–based approach that should profitably deliver effective new management tools, and develop an integrative model of the information that animals acquire from eavesdropping on predator scents within the food web. This model clarifies how predator odours can influence all trophic levels, from interference competition directed at smaller predators to predation and herbivory, exploiting direct and indirect pathways and landscapes of fear to manipulate spatial and temporal patch choice and life history decisions. We illustrate how the application of this model can focus future research and enhance the successful application of predator odour-based deterrents.

O7 - Weak effects of farming practices corresponding to CAP greening measures on farmland bird diversity

Johan Ekroos[1], Juha Tiainen[2], Tuomas Seimola[2], Jukka Rintala[2], Irina Herzon[3]

[1]Lund University, Lund, SE, johan.ekroos@cec.lu.se
[2]Natural Resources Institute Finland, Helsinki, FI
[3]University of Helsinki, Helsinki, FI

The current EU Common Agricultural Policy (CAP) formulates three greening measures (increasing crop diversity, maintaining permanent pastures and introducing ecological focus areas) which are intended to benefit farmland biodiversity. There is little evidence so far to support that these measures would be effective. We studied how farmland bird diversity respond to farming practices that functionally corresponds to the greening measures, i.e. crop diversity (calculated using the inverse Simpson's index), the proportion of long-term grazed pastures on arable land, and set-asides (which would functionally correspond to ecological focus areas) using an extensive data-set collected in Southern Finland. The study region comprised 40 % of the agricultural areas of the whole country, and territory mapping of breeding farmland birds covered 1.2% of the regional agricultural land cover and 0.5 % of all farmland in Finland. Once adjusting for landscape variability, we found relatively weak responses of the farming practices corresponding to the three greening components. Farmland bird diversity was positively affected by increasing proportions of long-term grazed pastures, and to a lesser extent of set-asides, whereas crop diversity did not affect farmland bird diversity at all. Instead, increasing availability of non-crop field boundaries had a strong positive effect on farmland bird diversity. The weak diversity responses of the studied farming practices was explained by marked differences in species-specific responses, involving contrasting interactions between landscape variability and farming practices amongst species. Our results suggest that the effects of the actual greening measures currently implemented across Europe will generate highly context-dependent outcomes on individual farmland bird species, and as a consequence low overall effects on farmland bird diversity.

O8 - Linking population trends of farmland birds to agricultural land-use change: an appraisal of drivers to target conservation actions

Jana Sabrina Jerrentrup[1], Stefan Mecke[1], Jens Dauber[1], Sebastian Klimek[1]

[1]Thünen Institute of Biodiversity, Braunschweig, DE, sabrina.jerrentrup@ti.bund.de

Over the last decades, changes in agricultural land use have impacted on populations of farmland birds across Europe. Investigating how farmland bird populations have changed over time in relation to agricultural land-use modifications is a crucial part to target conservation actions. Although associations between population trends of farmland birds and changes in agricultural land use are well established in the literature, analyses are often hampered by the lack of detailed spatial and temporal data on agricultural land use.

Here, we aim at analysing changes in farmland bird populations and their drivers in Lower Saxony (Germany) between 2003 and 2013; a time period characterised by marked changes in agricultural land use, such as increased maize cultivation and a widespread loss of set-aside arable land. We use detailed spatial data on agricultural land use from the Integrated Administration and Control System (IACS) and monitoring data from the Common Breeding Bird Survey. Analyses are based on 113 monitoring sites (1 km²) that contain a utilized agricultural area of at least 10%. We focus on those species listed in the Farmland Bird Indicator (FBI) and a subset of farmland bird species breeding on agricultural fields. Population trends of farmland birds were analysed using generalized linear mixed models. In order to link these trends to agricultural land-use change, we focused on highly dynamic agricultural variables over time (e.g. crop diversity, percentage cover of maize, grassland, set-aside land and spring-sown crops). First results indicate region-specific trends of farmland bird populations. While on some monitoring sites populations decrease over time, others show increasing or stable populations. In a next step, we will analyse the drivers responsible for those spatial variations in population trends. Our approach will contribute to tailor effective conservation actions to regions characterised by agricultural land use supporting farmland birds.

O9 - Impacts of salvage logging to cross-taxonomic functional and phylogenetic diversity

Simon Thorn[1]

[1]Bavarian Forest National Park, Grafenau, DE, simon@thornonline.de

The amount of forest affected by stand-replacing natural disturbances, such as wildfires, windstorms and insect outbreaks, has drastically increased over recent decades resulting in billions of disturbance-affected trees per year. Hence, the practice of removing the resulting dead or injured trees (i.e. salvage logging) has become increasingly controversial because of its impacts on biodiversity. Despite numerous studies focused on taxonomic diversity, empirical evidenceabout how functional and phylogenetic diversity and underlying assembly mechanisms (i.e. environmental filtering vs. limiting similarity) are influenced by salvage logging arescarce. We conducted species surveys of birds, saproxylic beetles, vascular plants, bryophytes, lichens, and wood-inhabiting fungi in experimentally logged storm-felled coniferous forest stands in Central Europe over 7 consecutive years. We used species ecological traits combined with phylogenetic trees and null-models to estimate the impact of salvage logging to standardized effect sizes of mean pairwise functional-phylogenetic distances.

All dead-wood dependent taxa except epixylic bryophytes tended to display significantly higher species richness on unsalvaged plots. By contrast, the species richness of taxa that dependent not directly on dead-wood displayed no significant response. All dead-wood dependent taxa were altered towards more random assembly mechanisms either due to displaying decreasing competition or decreasing environmental filtering on salvaged plots. Only assembly mechanisms of epigeal bryophytes (not dead-wood dependent) responded to salvage logging by displaying an increase in environmental filtering. The direction of shifts in assembly mechanisms of dead-wood dependent taxa may reflect stochastic extinctions from functional-phylogenetic space under a major resource reduction.

O10 - Evaluation of an integrative strategy for biodiversity protection in forests

Inken Dörfler[1], Wolfgang W. Weisser[1], Martin M. Gossner[1], Jörg Müller[1]

[1]Technische Universität München, Freising-Weihenstephan, DE, Inken Dörfler

The ongoing loss of global biodiversity requires new nature conservation strategies which are evaluated scientifically. The main strategy today is the designation of conservation areas. The focus on only this strategy can lead to the isolation of species populations and therefore an increasing risk for extinction. Thus, there is a need for the development of concepts that integrate nature conservation into existing managed systems. The forestry department Ebrach in northern Bavaria is an exceptional case for the implementation of such an integrative management concept. The accumulation of dead wood, the protection of trees with specific habitat structures and the establishment of larger and smaller areas without management are applied to achieve the conservation of biodiversity. The integrative nature protection concept has by now been implemented for about ten years, but so far the success of the strategy has not been evaluated. We investigated the effects of the change in forest management on forest structure and biodiversity and addressed the following questions:

(1) Does the implementation of the conservation strategy lead to an accumulation of dead wood in managed forests?

(2) Does the implementation of the nature conservation concept have an impact on biodiversity?

We used data of dead wood inventories conducted by the Bavarian State Forestry in the years 1997 (before implementation of the strategy) and 2011 (six years after implementation of the strategy). Besides that we did repeated examination of deadwood amounts, habitat trees and various species groups.

There was an accumulation of dead wood in more than half of the study plots. In this plots the amount of lying deadwood is increasing more than the amount of standing deadwood. The accumulation is independent of the living stand features. This shows that although the time span since the implication of the strategy is rather short it already has some influence with possible effects on biodiversity.

O11 - Let restoration be functional: Assessing the restoration success of an alluvial floodplain meadow using functional traits

Karina Engst[1,2], Helge Bruelheide[1,3], Annett Baasch[2]

[1]Martin Luther University Halle-Wittenberg, Institute of Biology/Geobotany and Botanical Garden, Halle, DE, karina.hofmann@botanik.uni-halle.de
[2]Anhalt University of Applied Sciences, Department for Nature Conservation and Landscape Planning, Bernburg, DE, karina.hofmann@botanik.uni-halle.de
[3]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, DE

In a 5-yrs restoration experiment, we evaluated the responses of floristic composition, species diversity, number and cover of target species, functional identity and diversity to four different methods of assisted re-colonization through species introduction: hay transfer and application of threshing material, combined with and without additional seeding of target species.

We hypothesized that i) assisted recolonization leads to a shift in species composition in direction of that of the reference sites as well as to an increase of species diversity and number and cover of target species with time. With respect to functional identity and diversity, we hypothesized that ii) the community weighted means (CWM) of key traits approach those of the reference communities and that iii) functional diversity (FD) steadily increases.

Across all treatments, floristic composition, species diversity, as well as number and cover of target species approached the reference values with time. In the last observation year, Shannon diversity was still lower in all treatment plots than in the reference plots, while the number of target forbs species had reached the reference levels. Furthermore, the threshing treatments were not different from the reference with respect to cover of target forbs species. We found that the community was also restored functionally for many, however, not all studied traits. CWM values of leaf traits such as specific leaf area (SLA) or leaf dry matter content (LDMC) did not differ significantly from those of the reference plots, whereas the CWMs of competitive and competitive-stress strategy types revealed significant differences. With the exception of biennial life span and self-pollination all treatments approached the reference and indicated a positive trajectory. With respect to functional diversity we found steadily increasing FDs for all traits except life span.

We demonstrated that assisted recolonization methods are appropriate measures to achieve the restoration with respect to species composition of a given community and the establishment of target species. Taking the trait approach into account showed that the restored meadow were already as functional as the reference plots. These insights do not only contribute to our functional understanding of restoration processes but also allow a more differentiated assessment of restoration success.

O12 - Wetland biodiversity in low-intensity pastures, straw meadows and fallows - a multitrophic comparison

Roman Bucher[1], Martin F. Wedel[1], Martin H. Entling[1], Christian Andres[2], Herbert Nickel[3]

[1]University of Koblenz-Landau, Landau, DE, bucher@uni-landau.de
[2]Planungsbüro Andrena, Werbach-Gamburg, DE
[3]Ehrengard-Schramm-Weg 2, Göttingen, DE

Wet grasslands often support a highly diverse and specialized flora and fauna, but have been subject to dramatic losses due to land use change. Here, we compare restored low-intensity pastures with old straw meadows and with fallows in a fen area in the northern pre-Alps. We sampled plants, leafhoppers and spiders in seven sites per land use type.

Plant species richness was significantly enhanced by grazing and mowing compared with fallows. In contrast, species numbers and abundances of leafhoppers and spiders were highest in pastures and lowest in meadows. Endangered plant species were significantly more diverse on meadows compared with pastures and fallows. The diversity of endangered leafhoppers and spiders, however, were not significantly affected by the management type. Our analyses further confirm that plant species richness was inversely correlated with nutrient availability. Leafhopper and spider species were mainly affected by the management type. In addition, the number of leafhopper species was positively correlated with the number of plant species.

Although fallow plots were poorer in terms of species richness, their leafhopper and spider assemblages were very differentiated and comprised a number of exclusive species, some of which were endangered. Our results suggest that on a landscape scale, maximum biodiversity can best be maintained by the diversification of management types. Enhanced abundances of leafhoppers and spiders in pastures may improve prey availability for predators such as birds, reptiles and amphibians. Low-intensity grazing is currently rather uncommon in Central European fens, but our results encourage more widespread use of cattle for managing this type of habitat.

P1 - Effects of shifting management to temporary fold grazing on species rich grassland vegetation

Birgit Schröder[1], Marian Koch[1], Anke Günther[1], Gerald Jurasinski[1]

[1]University of Rostock, Rostock, DE, birgit.schroeder@uni-rostock.de

Nutrient-poor grasslands are rare habitats in Central Europe. These grasslands are biodiversity hotspots and therefore valuable to nature conservation. Typically they have formed under historic land use regimes with low-intensity cattle or sheep grazing. However, management of nutrient-poor species-rich grasslands is often far from ideal. Here, we address the effect of a change from low intensity grazing by traditional herding to free-ranging grazing grazing in temporary fenced areas in semi-natural dry grassland communities and from occasional mowing to sheep grazing in temporary fenced areas in wet grassland communities in a nature reserve in Northeast Germany.

We analyze the change in species composition, diversity on various scales, and ecological indicator values of vegetation communities based on repeating a 20-year old phyto-sociological survey, 10 years after the change in management occurred. Since the exact locations of plots could not be reconstructed, we use a stratified random resampling within the respective vegetation types repeating the sample size of the first survey.

After two decades we did not see a pronounced change in plant species alpha, beta, and gamma-diversity. However, the analysis of indicator values indicates a slight but not significant trend to more eutrophic conditions. Despite low species turnover, we observed marked changes in frequency and abundance of some species leading to a strong change in community composition and in associated trait variables (increase of graminoids on the expense of herbs) in the wet grassland. Contrastingly, in the dry grassland, there was no unambiguous change in common ecological preferences or life history traits. Thus, whereas the shift from traditional herding to fenced grazing seems to have minor effects in the short time period investigated, major changes in vegetation composition resulted from the shift from occasional mowing to fenced grazing.

P2 - Spatially explicit forecasting tool for flood meadows restoration

Johannes P. Gattringer[1], Nadine Maier[2], Tobias W. Donath[3], Annette Otte[1], Lutz Breuer[2], Phillipp Kraft[2], Sarah Harvolk[1]

[1]Division of Landscape Ecology and Landscape Planning, Justus Liebig University Giessen, Giessen, DE, johannes.gattringer@umwelt.uni-giessen.de
[2]Division of Landscape, Water and Biogeochemical Cycles, Justus Liebig University Giessen, Giessen, DE
[3]Institute for Natural Resource Conservation, University of Kiel, Kiel, DE

In Central Europe, species rich grasslands have decreased in area and habitat quality since the middle of the 20th century. Especially flood meadows in lowland regions are among the most threatened plant communities in Central Europe. To restore these habitats and maintain the diversity of river corridor plants, numerous conservation and restoration measures have been established in the last two decades.

With the interdisciplinary project entitled "Development of a spatially explicit forecasting tool for the ecological assessment of flooding events in floodplain habitats" we are going to provide substantial knowledge on the distribution of river corridor plants. Based on a spatially explicit hydrological model of the study region, computed by our colleagues from the Chair of Landscape, Water and Biogeochemical Cycles, we will model the probability of occurrence of several river corridor plant species.

The aim of the project is to develop a spatially explicit forecasting tool that simplifies the decision-making process of conservation and restoration measures for nature conservation authorities. With a possible prior-estimation of the restoration success the amount of false investments in conservation measures could decrease.

P3 - Effects of landscape composition and configuration on bird diversity and community composition in agricultural landscapes

Sarah Redlich[1], Emily Martin[1], Beate Wende[1], Ingolf Steffan-Dewenter[1]

[1]University of Würzburg, Department of Animal Ecology and Tropical Biology, Biocentre, Würzburg, DE, sarah.redlich@uni-wuerzburg.de

Central European agricultural landscapes have experienced dramatic changes, primarily driven by agricultural intensification, which create trade-offs between production and conservation functions. High levels of agrochemical inputs, the removal of seminatural habitats and field boundaries, and specialization of farming have resulted in simplified landscapes and high losses of biodiversity both within and outside the agricultural mosaic. Farmland birds, in particular, have been subject to substantial losses in abundance and diversity. In this study, we assessed bird diversity in an agricultural region in Lower Franconia, central Germany. Despite being highly intensified, the heterogeneity of the region offers an ideal opportunity to study the effects of landscape composition and configuration on bird diversity and community composition. Bird surveys were conducted as part of a large-scale EU study focused on above- and belowground ecosystem services in agroecosystems. These surveys were used to describe the state of the bird communities based on species identity, feeding guilds, habitat preferences and red list status. In a second step, regional spatial land cover and management data were used to determine the relationships between bird communities and landscape composition and configuration at different spatial scales. We focused on the effects of habitat availability, crop diversity, the amount of organic farming and edge density in the surrounding landscapes. The overall goal was to test the hypothesis that agricultural management practices and landscape structures favoured under current EU agri-environment schemes can enhance bird diversity and conservation, in particular for species most reliant on agricultural landscapes for nesting and foraging.

P4 - From meadow to shallow lake: Vegetation change after rewetting of a coastal brackish fen

Marian Koch[1], Franziska Koebsch[2], Juliane Hahn[1], Gerald Jurasinski[1]

[1]Landscape Ecology Group, University of Rostock, Rostock, DE, marian.koch@uni-rostock.dwe
[2]Deutsches GeoForschungsZentrum GFZ, Potsdam, DE

Year-round flooding can be a cost-effective measure for rewetting of highly degraded fens and is gaining in popularity for lowland fen restoration in Europe. However, flooding is a heavily destabilizing force on ecosystems, and success control is mandatory. We investigated the short term effects of such permanent inundation on species composition and spatial distribution of vegetation of a formerly drained coastal fen and address the question if re-establishment of peat-forming reed vegetation is foreseeable.

For vegetation mapping and monitoring we combined permanent plot data acquired during 4 years after shallow flooding, high-resolution aerial imagery, a LIDAR-based elevation model and water level data.

Vegetation in the years after flooding exhibited clear separation in patches dominated by few or single species. Thus, patches could be clearly distingueshed in both the ground truthing and the remote sensing data, and an object based classification approach could be used.

Five vegetation types were distinguished, and we analyzed their spatial distribution and succession patterns throughout the years.

Pre-existing vegetation, its spatial arrangement and water levels played a major role in secondary succession. Existing reed belts of Phragmites australis showed high stability and spread, but the amount of the latter was not consistent through the years and at all inundation depths. Existing stands of Bolboschoenus maritimus were outcompeted by Schoenoplectus tabernaemontani or vanished and formed relatively stable ponds of open water with hydrophytic species. We concluded that the expansion of reed as peat forming vegetation will likely proceed slowly, but fluctuations in water levels and edge effects will keep a mosaic of vegetation and open water in the near future.

The combination of remote sensing methods with classical permanent plot monitoring proved to give valuable additional insights into short-term succession processes.

P5 - Analysis of genetic diversity and structure of lowland populations of the endangered plant Arnica montana L.

Katrin Lea Rokitte[1], Verena Lauströer[2], Eva Mosner[2], Ilona Leyer[2], Sascha Liepelt[1]

[1]Philipps-Universität Marburg, Marburg, DE, katrin.rokitte@gmx.net
[2]Hochschule Geisenheim University, Geisenheim, DE

A decrease of biodiversity is globally recorded and many formally common species are now listed as endangered. One of them is *Arnica montana* L., a characteristic perennial plant species of acidophilus nutrient-poor grassland with open ground in Europe. Over the last decades this kind of habitat decreased, but even in the remaining habitatsa strong decline and even loss especially of lowland populations has been recorded.

The goal of a new joint project in Germany is to develop a transferable management concept for *A. montana*. As part of this project we analyzed the genetic diversity and structure of eight populations in our model region Hesse, using 14 polymorphic nuclear microsatellite markers. In each population, 30 plants with the most spatial distance to each other were analyzed to minimize the sampling of clones. *A. montana* is capable of vegetative as well as sexual reproduction and is considered to be self-incompatible.

We expect to identify the spatial genetic structure of our populations and aim to understand if (i) the genetic diversity and structure differs between lowland and highland populations, if (ii) there is a correlation between genetic distance and geographic distance, and if (iii) population size is an indicator for genetic diversity.

Our study contributes to a better understanding of the genetic diversity and structure of *A. montana*. This is a first step for developing a transferable genetic monitoring system and to identify appropriate donor populations for populations with very low genetic diversity. Results will be presented and discussed.

P6 - „Local is best!“ or „Is local best“?

Jutta Reiker[1], Benjamin Schulz[1], Volker Wissemann[1], Birgit Gemeinholzer[1]

[1]Justus Liebig University, Giessen, DE

For restoration purposes nature conservation enforces the usage of local genotypes based on the „local-is-best“ (LIB) theory. This, however, may not always be the best choice for biodiversity conservation and in several cases recommendations to refrain from the LIB theory have been made. We here test, if in common widely distributed, outcrossing species with no obvious signs of local adaptation strict adherence to the LIB approach render unnecessary.

For this we compare the population genetic pattern of indigenous populations to populations on sites restored with non-local seed material after several years of restoration and establishment. Ten *Daucus carota* L. populations after up to 20 years of restoration were compared to ten populations in nature conservation areas by using ten microsatellite markers. Gene diversities ranged from H_e = 0.682 to 0.858 with slightly higher average diversities in indigenous populations and on older restored sites. High intrapopulation variability and negligible population differentiation across all populations (F_{st} = 0.043) were observed. The population genetic results are indicative for strong population admixtures. However, by comparing older restored sites with indigenous ones the genetic differentiation is not negligible which might be indicative for changes in restoration practices.

Overall, novel genotype introduction into the region resulted in no negative effects upon regional species persistence, even after up to 20 years of restoration with non-local seed material. However, recommendations to refrain from the LIB theory for this common, widespread, and highly cross-pollinated species without obvious signs of local adaptation without any limitations can currently not be made.

P7 - Identifying provenances for planting measures - large scale population genetic patterns of a dispersal restricted species, Frangula alnus

Eva Mosner[1], Klaus Eimert[1], Ulrike Hüwe[1], Birgit Ziegenhagen[2], Alwin Jansen[3], Ilona Leyer[1]

[1]Geisenheim University, Geisenheim, DE
[2]University of Marburg, Marburg, DE
[3]Northwest German Forest Research Institute, Göttingen, DE

Guided by the Convention on Biological Diversity the conservation of genetic diversity is explicitly implemented in national legislation such as the Federal Nature Conservation Act of Germany. Here it is stated that plantings must not be based on nonlocal provenances due to the risk of outbreeding depressions caused by poor adaptations to prevailing environmental conditions of nonlocal planting or sowing material. This, in turn, is of particular concern for stakeholders such as commercial nurseries that usually supply the planting material for landscaping measures and reforestations. The Federal Ministry for the Environment and Nature Conservation Germany provides a classification scheme of 6 major regions as provenances inferred from geographical regions as the basis for sowing and planting material. However, it is highly questionable if these defined regions actually resemble population genetic patterns. Aim of our study was to investigate the population genetic structure of a shrub species, *Frangula alnus* (alder buckthorn), to uncover potential regions as provenances of seed or planting material. As *F. alnus* is mainly insect pollinated and bird dispersed we expected gene flow to be rather low and hence a genetic differentiation of populations. We investigated the population genetic structure of overall 24 different stands distributed throughout Germany using microsatellite analysis of 7 loci. Genetic analyses revealed a structure which, as expected, did not reflect the 6 predefined provenance regions but mainly two regions, i.e. a western and an eastern population. Results point to the need for detailed population genetic studies to determine species specific provenance regions as the current regulations may lead to inappropriate conservation actions and management measures at potentially serious societal costs.

P8 - Identifying habitat specific threats for restoration management of degraded Arnica montana populations

Verena Lauströer[1], Ute Zerahn[3], Florian Grammel[1], Tobias W. Donath[2], Ilona Leyer[1]

[1]Plant Ecology and Nature Conservation, Institute of Botany, Hochschule Geisenheim University, Geisenheim, DE, verena.laustroeer@hs-gm.de
[2]Department of Landscape Ecology, Institute for Natural Resource Conservation, Christian-Albrechts-University zu Kiel, Kiel, DE
[3]Department of Landscape Ecology and Resource Management, Interdisciplinary Research Centre, Justus-Liebig-University Gießen, Gießen, DE

Arnica montana is a characteristic species of nutrient poor grasslands in Central Europe. Although protected by national and international law, populations have been declining strongly over the last few decades especially in lowland regions. The aim of this study was to identify the reasons for this decline. To this end we compared the habitat characteristics of sites with large populations, small populations and sites where *A. montana* has become extinct during the last decade. We studied 32 sites across Hesse, Germany, focusing on soil physical and chemical variables, plant available nutrients and vegetation characteristics (e.g. species richness, biomass production, vegetation cover, mean Ellenberg indicator values). No significant differences in pH-value and soil reaction indicator value were detected among site categories. The nutrient indicator value and silt content were significantly higher in habitats from which *A. montana* had vanished in comparison to sites where large populations have persisted. In accordance, soil C/N ratio showed the opposite pattern with large populations having higher values indicating reduced nutrient mineralization. Our results suggest that lower nutrient input via air pollution and an enhanced depletion of nutrients are needed to maintain and restore viable *A. montana* populations.

P9 - Ex situ populations in botanic gardens and their suitability for conservation purposes

Christina M. Müller[1], Björn Huwe[2], Volker Wissemann[1], Birgit Gemeinholzer[1]

[1]Justus Liebig Universität Systematic Botany, Giessen, DE,
Christina.M.Mueller@bot1.bio.uni-giessen.de
[2]Universität Potsdam Biodiversitätsforschung/ Spezielle Botanik, Potsdam, DE

*Ex situ*cultivation in botanic gardens are seen as one method to preserve plant spe-

cies diversity and genetic variation for nature conservation. However, there is growing evidence that contemporary evolutionary processes can rapidly affect genotypic pattern in response to novel selection regimes. These microevolutionary changes that are observed in contemporary times have been recorded for introduced, captive, and harvested populations and might render ex-situ populations unsuitable for conservation purposes. Thus, we here test, if ex-situ populations are affected by contemporary evolutionary processes by comparing their population genetic patterns with the ones of their in-situ source populations after ~30 years of cultivation. Populations of three different species, *Alyssum montanum*, *Onosma arenaria,* and *Helianthemum nummularium*, cultivated at the Botanic Garden Mainz since 1982, were compared with their respective in-situ populations at the nature protected area Mainzer Sand, where earlier investigations in *Silene otites* (Lauterbach et al. 2012) already resulted in divergent population genetic pattern. Inter sample sequence repeats (ISSR) were applied on 15 individuals per site and each species. The results provide evidences, (i) if and how the genotypic pattern changed during cultivation, (ii) if species react similar under similar novel selection regimes, and (iii) if ex situ cultures in botanic gardens are suitable for conservation purposes.

P10 - Seedling interaction between native conifer species and the exotic Pseudotsuga menziesii

Claudio Grefen[1], Eugenia Hosius[2], Christina Mengel[1], Birgit Ziegenhagen[1]

[1]University of Marburg, Marburg, DE
[2]ISOGEN am Institut für Forstgenetik, Göttingen, DE

Douglas fir (Pseudotsuga menziesii), native to western North America, was first introduced to Germany in the mid-19th century and after provenance testing has become part of the managed forests due to its productivity in relatively short rotations. In the face of a changing climate and an increased occurrence of extreme weather events like European windstorms as well as drought stress, German forest management considers P. menziesii to be a suitable alternative for Norway spruce (Picea abies). P. menziesii is assumed to have a greater tolerance towards drought and wind and simultaneously fits forestry's requirements of a high yield tree. Thus, increasing proportions of Douglas fir may be expected in the near future. Since P. menziesii is not native in Germany, the question of potential threats to native plant habitats and species arises. While a lot of ecological research has been done on old-growth Douglas-fir forests knowledge about an invasive effect at very early stages is still missing. This study focuses on the question whether seedlings from P. menziesii may have an advantage over seedlings from Picea abies and Abies alba (European silver fir – as a second relevant conifer target) during the process of germination. The phenomenon of an inhibited germination of the natives was found for other exotic -native plant combinations and was explained by non-compatible root exudates. Our study is based on a germination experiment in growth chambers in which all three partners were synchronized beforehand to guarantee simultaneous germination. P. menziesii germinated in direct neighborhood with germinating seeds of the target species. As a control, germination rates of all three species were investigated separately as well. Our results will contribute to a better understanding of seedling interaction and help to explore putative invasive effects at stages that are crucial for survival and micro-evolutionary processes of the target species.

P11 - Evidence-based conservation: A database on habitat requirements of endangered vertebrates in Hesse (Germany)

Ralf Sauerbrei[1], Tobias Erik Reiners[2], Andrea Früh-Müller[1], Volkmar Wolters[1], Eva Diehl[1]

[1]Justus-Liebig-University, Department of Animal Ecology, Gießen, DE,
Ralf.Sauerbrei@allzool.bio.uni-giessen.de
[2]Senckenberg Research Institute and Natural History Museum Frankfurt, Gelnhausen, DE

A large amount of scientific literature focuses on habitat variables affecting endangered species that are relevant for landscape planning. However, information on this issue is highly dispersed and difficult to access by practitioners. As a contribution for overcoming this problem we reviewed the publications on all Hessian vertebrate species, which are considered as endangered species in the EU Birds and Habitats Directive or which are recorded in the Red List of Hesse. We searched for these publications in “ISI Web of Knowledge” by using the species’ scientific names and “habitat” as key words. 663 papers from over 130 journals were then suited for extracting habitat variables which affected 124 species (75 birds, 32 mammals, 10 amphibians and 7 reptiles, respectively). The review delivered a total of 2539 independent cases of habitat variables including land-use and biophysical effects on occurrence, density or reproduction of selected species. Almost 90 % of these cases covered land-use effects, while biophysical variables such as climate or geology were only occasionally addressed. Most cases focused on forest habitats followed by standing water bodies, grassland and arable habitats. Concerning the spatial scale, local effects were more frequently investigated than those at the landscape level. Preliminary analyses show that species can be clustered according to similar habitat requirements. Furthermore, we developed a software tool that facilitates the use of our database by allowing systematic search routines and comfortable information export. Currently we expand the available data set by including complementary information on endangered invertebrates. Moreover, the applicability of knowledge-based modeling approaches for predicting suitable habitats in parts of Hesse are tested. Scientific literature provides comprehensive evidence on habitat requirements of endangered species and should be used more intensively to support sustainable landscape management.

P12 - The implementation of a long-term monitoring program in arid south-western Madagascar

Joachim Nopper[1], Dresy Lovasoa[2], Yedidya Ratovonamana[3], Jana Carina Riemann[1]

[1]Universität Hamburg, Hamburg, DE, joachim.nopper@uni-hamburg.de
[2]Madagascar National Parks, Toliara, MG
[3]Université d'Antananarivo, Antananarivo, MG

The long-term impacts of environmental changes on species and species' communities have rarely been documented especially in tropical countries. This is partly due to the difficulties of obtaining long-term funding. One possibility to overcome this problem is to implement biodiversity monitoring programs into management plans of in-country authorities. Monitoring programs often exist, but lack input from the scientific community. If in-country authorities can be supported scientifically, the gained information can then serve not only to inform policy decisions but also to further the understanding of species' and communities' reactions to environmental fluctuations.
In Madagascar, biodiversity programs have been implemented within the National Park network by the nation's National Park authority. Monitoring plans already exist for certain flagship taxa but data is seldom used from the scientific community to inform decision making processes. We are in the process of extending the management plan of Madagascar National Parks for the Tsimanampetsotsa National Park.To incorporate additional monitoring activities, eco-guards need to be trained in survey techniques and the quality of the recorded information needs to be assessed and controlled. We will integrate a reptile diversity monitoring and will accompany the program throughout the coming years. This will benefit the national authority as much as it will benefit our aim to learn more about reptile community dynamics in the region.

P13 - Influence of river morphology and river-floodplain system on the fish community of the River Elbe

Olga Kolychalow[1], Dr. Andreas Anlauf[1]

[1]Bundesanstalt für Gewässerkunde, Koblenz, DE, Kolychalow@bafg.de

Anthropogenic restructuring of the River Elbe reduced the heterogeneity of river morphology and flow velocity as well as connectivity to near located standing and flowing waters. Further, large parts of the river were diked off resulting in reduction of recent floodplains. Thus, morphological conditions to meet fish requirements during the life-cycle have been significantly changed.

The present study focuses on the relationship between the fish community of the middle part of the River Elbe and the river morphology and connectivity with its floodplain. Therefore, fish community data sampled in 15 groyne-fields at Elbe-km 439 - 445 (Nov. 2005 - Sep. 2008) was analysed according to species requirements

for reproduction in rheoparous, euryoparous and limnoparous species and relative abundance.

The juvenile fish community of the investigated groyne-fields is dominated by indivduals of euryoparous species (80.3 ± 9.9%) followed by rheoparous (15.1 ± 10.1%) and limnoparous species (2.4 ± 4.1%). Compared with historic data a shift in fish community from rheophilic (most are also rheoparous) to indifferent species can be observed. However, rheoparous (R^2 = 0.7804, $p < 0.01$) and limnoparous species (R^2 = 0.544, n.s.) benefit from an elevated average discharge over a period of four weeks during the spawning and developing period in relation to euryoparous species (R^2 = 0.7572, $p < 0.05$). Though, the quantity of limnoparous individuals increased lower than expected. We suggest unfavourable conditions in the main river and low connectivity or absence of oxbow lakes and pools, respectively for limnic fish species.

P14 - Wildlife conservation in West African rainforests - Status, perspectives and potentials

Denis Kupsch[1], Kadiri Serge Bobo[2], Matthias Waltert[1]

[1]Georg-August-Universität Göttingen, Workgroup Endangered Species Conservation, Department of Systemic Conservation Biology, Göttingen, DE
[2]University of Dschang, Department of Forestry, Dschang, CM

The Gulf of Guinea Forests constitute the largest continuous forest block of the whole West African forest biodiversity hotspot. To conserve its exceptionally diverse species pool, including endangered wildlife such as Elliot’s Chimpanzee and the Central African Elephant, several conservation strategies had been implemented. In Southwest Cameroon a good number of protected areas had been established along with barely protected Forest Management Units (FMUs). Additionally, integrated conservation and development approaches focused on sustainable land use practices in largely intact forest landscapes around reserves, which are dominated by rural agroforestry systems. However, bushmeat hunting remained a major threat to wildlife and key species for conservation were already predicted to face extinction in protected areas in the nearer future. Furthermore, little is known about the status of wildlife in agroforestry matrices, which would be of utmost importance, since they are facing a new agro-industrial wave leading to habitat conversion and fragmentation, especially in the context of palm oil. To evaluate the performance of conservation strategies, we carried out a systematic transect survey in an agroforestry landscape (survey effort L=182km) and compared the results with recent wildlife data provided by conservation agencies from Korup (L=176) and Mount Cameroon (L=63km) National Parks as well as two FMUs (L=96km, L=47km). Our results highlight the alarming situation of chimpanzees and elephants numbering few hundreds and being largely confined to protected areas. However, they were still encountered in agricultural matrices. While in FMUs also other hunted wildlife seem to approach extinction, their densities were considerably high

in agroforestry systems, stressing their importance for stabilizing wildlife populations. We discuss that existing conservation regulations need to be urgently enforced to avoid massive extinction by focusing on improved patrol management in reserves and the establishment of binding landscape management plans to sustain traditional agroforestry systems in place of agro-industrial developments.

P15 - Selling emission reductions from peatland restoration: do we need post-rewetting monitoring of greenhouse gas exchange?

Anke Günther[1], Stefanie Böther[1,2], Silke Hüttel[2], Gerald Jurasinski[1]

[1]University of Rostock, Landscape Ecology, Rostock, DE, anke.guenther@uni-rostock.de
[2]University of Rostock, Agricultural Economy, Rostock, DE

In a number of German federal states, voluntary emission certificates traded as MoorFutures® have been established as an instrument to fund peatland restoration. One such certificate accounts for the reduction of greenhouse gas emissions by one ton of CO_2-equivalent through peatland rewetting. The price for the certificates depends on the estimated emission reduction, the rewetting costs for each project, and a mark-up to hedge against over- or underestimated emissions. Since the certificates are sold before rewetting, the estimated emission reduction is based on the anticipated vegetation and water level change. The current approach to evaluate how successful the rewetting was, however, only considers vegetation and water level monitoring but not direct measurements of greenhouse gas exchange.

Our research compares the estimates of post-rewetting emissions with measured greenhouse gas exchange for a hypothetical MoorFutures® project to investigate how the inclusion of greenhouse gas monitoring in terms of cost and tons CO_2-equivalent may change the price of a hypothetical certificate. For this reason, we compare emission estimates derived according to the MoorFutures® methodology and actually measured greenhouse gas fluxes from a 15-year rewetted fen (Günther et al. 2014 GCBB) for a number of vegetation scenarios. Based on these measures, we calculate the price for one MoorFutures® for both the estimated and measured emissions and each of the vegetation scenarios using a range of rewetting costs.

We find in the majority of the scenarios that the MoorFutures® procedure underestimated the emission reduction compared to the measured values. Incorporating further the costs of greenhouse gas monitoring and considering that due to the underestimation in fact more certificates could have been sold, leads to a price increase for a MoorFuture®. In the light of our findings, the strategy so far pursued by the issuer —holding back a considerable number of certificates serving as a reserve— could become unnecessary, in particular if the post-rewetting greenhouse gas exchange is measured directly. Thus, post-rewetting greenhouse gas monitoring could result in a price reduction for a certificate while increasing reliability and trust for purchaser at the same time.

P16 - Insectivorous and open-cup nester bird species suffer the most from urbanization

Peter Batary[1], Orsolya Mathe[2]

[1]Georg-August-University, Agroecology, Göttingen, DE, pbatary@gmail.com
[2]Hungarian Department of Biology and Ecology, Babeş-Bolyai University, Kolozsvar, RO

Urbanization effects in an Eastern European city depend on feeding and breeding traits of bird communities with stronger negative effects on more specialized traits. To assess how urbanization affects feeding and breeding traits of bird communities in Cluj (Romania). Based on a stratified random sampling we selected 61 study squares of 200 × 200 m for bird surveys representing the following habitats: suburban, residential and apartment complex (representing an increasing urbanization gradient). We carried out bird censuses in both breeding and wintering seasons. The observed bird species were classified according to their feeding guilds and nesting sites. Insectivorous and open-cup nesting species were most abundant in suburban areas. Omnivorous species richness was not related to urbanization gradient. Species showed similar patterns of distribution during breeding and winter with respect to feeding habits. However, in case of nesting preferences, species richness of cavity nesters increased with urbanization gradient in winter, but decreased in the breeding season. Food and nesting site availability are key drivers in limiting more specialist species in utilizing city centres. Future studies should assess the effect of how green areas can counteract such negative effects of increasing urbanization in the context of such specialist trait limitations.

P17 - Pollen competition in Populus as a mechanism to safeguard the pure species status

Ronald Bialozyt[1,2], Marc Niggemann[2], Birgit Ziegenhagen[2]

[1]Northwest German Forest Research Station, Göttingen, DE, ronald.bialozyt@nw-fva.de
[2]Philipps University, Marburg, DE, ronald.bialozyt@nw-fva.de

The extent and the consequences of interspecies gene flow are in the focus of evolutionary biologists as well as conservation ecologists. Crossings between the black poplar *Populus nigra* and its hybrid form *P. x canadensis* has been examined in greenhouse experiments and in natural populations. However, the magnitude of introgression and the extent of pollen competition between natural and hybrid poplars is hardly quantified.

Genetic data on gene flow within a population of poplars trees from both species are available from a field study in the floodplain of the river “Eder” in Western

Germany. These data are useful to describe recent gene flow between adult trees and collected seed samples. Applying these data in as simulation model, we conducted simulation experiments to explain the discrepancy between the proportion of seeds fathered by hybrid trees and the proportion of hybrid trees in the vicinity of the sampled mother trees. We tested three common probability density functions as well as a pollen dispersal function that has been successfully fitted to the intra-population gene flow of the studied poplar population. Additionally we included in our model a parameter to account for pollen competition between both species.

In using different values for the proposed barrier, the results clearly show that barrier against hybrid pollen must exist in order to obtain the proportions of both pollen types in the seed set that of the sampled mother trees. The strength of resulting barrier was nearly independent of the used dispersal functions. Furthermore the simulated barrier has comparable values with previous values obtained in hand pollination experiments.

These results suggest, that the barrier is a good mechanism to protect P. nigra against gene flow from its hybrid. They also suggest, that these results have to be included in decision support systems on evaluating places for the establishment short coppice rotation plantations in Germany.

P18 - I‘m (almost) off then: abundance and pond use of a yellow-bellied toad (Bombina variegata) population in Thuringia.

Madlen Schellenberg[1]

[1]Institute of Ecology, Friedrich-Schiller University, Jena, DE,
madlen.schellenberg@hotmail.com

The yellow-bellied toad (*Bombina variegata*) is facing a rapid decline throughout Germany and is highly endangered in Thuringia. I calculated the population size of the formerly largest population in Germany in the Hainich National Park using the method of mark-recapture. For identification of individual toads I used their distinct underbelly pattern. During summer 2014 I registered 156 individuals in a total of 339 captures. The sex ratio of the population (3:1) showed a surplus of male toads. However male and female toads did not differ significantly in the number of captures. The population showed a high average survival rate of 0.94 and a rather low capture rate of 0.29. The total population size was estimated using a closed population model resulting in a population estimate of 262 ± 35 toads. In comparison to the population estimate of 3300 individuals in 1993 the need for conservation measures in this area becomes clear.

Furthermore a variety of 118 ponds was studied concerning differences between spawning ponds and residency ponds. Spawning ponds were significantly smaller, shallower and warmer than residency ponds and showed little or no vegetation cover. The toads avoided ponds which did not desiccate during the season due to a predictably high predator density. Chemical parameters of the water such as pH, conductivity and oxygen content seem to be a less important criterion for toads to choose a pond for spawning or not.

Since the surviving of this species in Germany strongly depends on conservation measures, such as the excavation of new ponds, the results of this study can improve the efficiency of the conservation of this species.

P19 - Effectiveness of conservation areas for protecting biodiversity and ecosystem services: a multi-criteria approach

Jaime García Márquez[1], Tobias Krueger[1], Carlos Páez[2], César Ruiz[2], Tito Muto[2]

[1]IRI THESys, Humboldt Universität zu Berlin, Berlin, DE, jaime.garcia.marquez@hu-berlin.de
[2]Conservation International – Colombia, Bogotá, CO

In research and policy agendas, the concept and methods to quantify and map ecosystem services are now extensively used to complement biodiversity approaches for conservation prioritization exercises. Tension arises when important areas for biodiversity do not spatially co-occur with areas of high provision of ecosystem services. We investigate the effectiveness of the current network of protected areas in simultaneously protecting biodiversity and ecosystem services and identify potential complementary areas in the central region of Colombia. We map, integrate using a spatial multi-criteria technique, and correlate five indicators (sensitive species, critical ecosystems, habitat quality, water provision and scenic beauty). Reflecting the uncertainty in criteria weights, multiple maps were created and overlain with current protected areas to investigate their effectiveness. A consensus and an uncertainty map were calculated from the simulations to identify multifunctional areas (areas of high value/provision of biodiversity/ecosystem services and low uncertainty). Current protected areas show intermediate to low levels of effectiveness. The percentage of overlap with simulated areas ranges from 3% to 56%. Water provision is the service least effectively protected (3% overlap). Biodiversity and ecosystem services indicators do not show high levels of correlation (all $p <$ 0.57). Sensitive species are negatively correlated with all other indicators, and strongest with water provision (p = -0.51, P < 0.001). Nevertheless, multifunctional areas not contemplated in the network of current protection areas were identified and mapped. The results of this study highlight the potential variability of outcomes introduced by stakeholder preferences and propose an approach to identify those multi-purpose areas that secure the long-term conservation of nature and its services and are robust to divergent stakeholder opinions, all aspects critical for the coming IPBES assessments.

P20 - Phytodiversity and ecological interactions of open, semi-open and forest habitats in the National Park Asinara (Sardinia, Italy)

Marc Wätzold[1], Tim Drissen[1], Robin Stadtmann[2], Jasmin Mantilla-Contreras[1]

[1]University of Hildesheim, Institute of Biology and Chemistry, WG Ecology & Environmental Education, Hildesheim, DE, waetzold@uni-hildesheim.de
[2]University of Hildesheim, Department of Geography, Hildesheim, DE

Mediterranean vegetation has been undergoing the assaults of man and his animals for over 10,000 years. Due to its central position in the Mediterranean Sea, the island of Asinara had a troubled history, with deep imprint on the vegetation. The largest part is more or less degraded by deforestation, fires and overgrazing. This caused a mosaic of open and semi-open habitats and suppressed the natural dominant vegetation type, Quercus ilex forest. Today, the island is managed as a National Park but there is no clear goal which vegetation should be supported.

To evaluate if secondary open vegetation, forest or both should be promoted, plant diversity of open and semi-open habitats were compared with forest habitats to draw conclusions for further management options. The vegetation was assessed with a total of 27 plots, each of 100 m2 and clustered with the modified TWINSPAN algorithm.

Considering diversity indices, the open and semi-open habitat types exceed the forest types. Additionally, four out of five surveyed endemic species are restricted to the open vegetation. Except one, all habitat types can be classified according to appendix I of the Habitats Directive. Furthermore, soil moisture and relative air humidity are significantly higher, temperatures significantly lower in the forest habitat types. These results are supported by the Ellenberg-Pignatti indicator values, which also indicate more nutrients within the forest types. The latter also exhibit a stronger root penetration as well as deeper soil depths. This results, combined with further studies about the islands herbivore and bat fauna concludes to restore the natural Q. ilex forest around the few scattered habitats and to support the rejuvenation through reduction of introduced grazing animals. However, the surveyed open and semi-open habitat types should be integrated in these actions, providing the majority of the islands plant diversity.

END OF SESSION 47

Session 48 - Effects of different land use practices on natural resources, biodiversity components and ecosystem services and functions
Short title: Effects of land use practices on natural resources

CHAIRS: ESTHER VERJANS, PROF PETER TAYLOR, PROF STEFAN FOORD

O1 - Land use and biodiversity conservation in the spiny forest ecosystem on the Mahafaly Plateau in southwestern Madagascar

Jörg Ganzhorn[1], Susanne Kobbe[1], Joachim Nopper[1], Yedidya Ratovonamana[1], Enzo Braskamp[1], Julian Ehlers[1], Balten Lauströer[1], Sylwia Marcek[1], Matthias Marquard[1], Domoina Rakotomalala[1], Jacques Rakotondranary[1], Lalatiana Randriamiharisoa[1], Soafara Raonizafinarivo[1], Esther Verjans[1]

[1]Universität Hamburg, Hamburg, DE, ganzhorn@uni-hamburg.de

Madagascar is known for its high degree of endemism and the degradation of its natural forests. Within Madagascar, the Mahafaly Plateau in south-western Madagascar represents one of the most unique and biologically rich regions, characterized by spiny forest, classified as a global biodiversity hotspot, and is listed among the “Global 200”. The present form of the ecosystem is threatened by anthropogenic forest destruction and climate change. Within this framework, we assessed the relationships between biological diversity and in-situ land management. While the current forms of agricultural and pastoral land utilization are not sustainable, the endemic vertebrates show remarkable resistance to changes of their forest habitat until degradation reaches a very advanced state. The area was home to a rich forest megafauna until a few hundred years ago. Due to the lack of resources, this arboreal fauna would not be able to survive in the present forest we consider to represent “pristine” or “undisturbed” forest. Also, the area still has some of the oldest baobab trees on earth, which do not seem to regenerate any more. These findings indicate that the region was and still is subject to very rapid environmental and climate change that could have wiped out the specialized plant and animal species even without human intervention. Species that still exist may be the ones that can cope with a large variety of conditions; though they still represent regional and global endemics.

Though species decline from pristine forests to agricultural fields, leftover structures in pasture and agricultural land, such as hedges or remnant forest structures maintain high biodiversity that decreases significantly only in the most degraded areas. The resistance and generalized characteristics of the remaining endemic species should allow their conservation in a human dominated matrix around forest remnants by simple means, such as by hedges or areas with sparse tree cover that could link the remaining forest.

This study is part of a BMBF funded project on development of sustainable land use in Madagascar (“SuLaMa”).

O2 - Land use effects on bat ensembles in two villages in Northern Limpopo, South Africa

Alain Smith[3], Corrie Schoeman[4], Barend Erasmus[2], Peter Taylor[1], Mark Keith[3]

[1]University of Venda, Thohoyandou, ZA, peter.taylor@univen.ac.za
[2]Wits University, Johannesburg, ZA
[3]University of Pretoria, Pretoria, ZA
[4]University of KwaZulu-Natal, Durban, ZA

Land use change poses a major threat to the biodiversity of species across the globe. There is a trend towards natural vegetation being transformed to highly modify human land uses. The structure of vegetation and vegetation clutter are known to affect bats. We tested the hypothesis that changes in bat ensembles would be driven by changes in vegetation structure due to land uses. We sampled bat diversity during wet and dry seasons at twelve sites from two villages in Northern Limpopo using acoustic recording of bat calls. While sampling we divided the land uses in the villages into four categories, peri urban, agriculture, abandoned or cleared and low utilisation. Bat diversity was quantified as the number of calls within 5kHz peak frequency sample groups which was used to calculate the functional diversity of each site using Estimate S rarefaction diversity estimates. The three dimensional structure of vegetation at each site was assessed using Light Detection and Ranging (LiDAR). Using mathematically derived fine scale parameters describing vegetation structure from the LiDAR images we compared the associated functional diversity between sites within villages. To determine how the vegetation structure within land uses would relate to the bat ensembles present we looked at how certain 5khz groups were related to the fine scale structural parameters using canonical correspondence analyses. Structural diversity was shown to have a positive effect on bat functional diversity. We found that the drier site had lower functional diversity than the site with higher rainfall. The functional groups were more strongly split by land use in the drier village where urban structures increased structural diversity. The use of 5khz blocks in the study allows these findings to be applied to other study areas easily, as the relationship between bat echolocation calls and functional groups is not specific to any region.

O3 - Drivers of small carnivore density, diversity and distribution within mixed landscapes of South Africa

Lourens Swanepoel[2], Peter Taylor[1,2]

[1]South African Research Chair on Biodiversity Value & Change, University of Venda, Thohoyandou, ZA
[2]School of Mathematical & Natural Sciences, Department of Zoology, University of Venda, Thohoyandou, ZA, lourens.swanepoel.univen@gmail.com

Africa is blessed with a rich small carnivore guild, which fulfill important ecological

services. However, little is known about their ecology, particularly their response to land use change. Especially in mixed landscapes small carnivores can be directly affected by human persecution, habitat modification or competitive exclusion by domestic pets. In contrast, low large carnivore densities that characterize mixed landscapes might release small carnivores from top down regulation, which could lead to increased diversity and density. Mixed landscapes may therefore harbor diverse small carnivore communities that could provide important ecosystem services to local communities. In a series of studies we have aimed to untangle the drivers of small carnivore diversity and distribution. Our study sites included rural villages, Biosphere reserves and commercial farms. In each of our study sites we attempted to stratify the site to include areas of minimal disturbance (natural sites), settlements and agricultural areas. Our research is underpinned by an occupancy modelling framework which can distinguish between ecological and observation processes. During a collective effort of around 6000+ camera trapping days over four different study sites we found overwhelming support that land use indeed affect small carnivore abundance and diversity. Furthermore, we consistently found that agricultural areas within mixed landscapes had not just a higher diversity of small carnivores, but more often also a higher density compared to both natural areas and areas with high human densities. The positive affect of agricultural areas on small carnivores seems to be mediated through either food abundance or habitat heterogeneity or both. However, size of small carnivores also seems to play a role, where larger (>5kg) small carnivores seems to lose the positive effects of agricultural areas. Surprisingly we also found that the agricultural matrix harbored some rare small carnivores (e.g. Meller's *Rhynchogale melleri* & Selous' mongoose *Paracynictis selousi &* black footed cat *Felis nigripes*). Our results show that agricultural areas in mixed landscapes can harbor diverse small carnivore communities, which include rodent specialists, which can provide important ecosystem services in terms of predation on rodent pests.

O4 - Responses of native grass species to rangeland‘s stressors: implications for ecosystem services and functions

Samuel Tuffa[1], Anna Treydte[1], Dana Hoag[2]

[1]University of Hohenheim, Stuttgart, DE, satukada@gmail.com
[2]Colorado state university, Fort Collins, US

Degradation of rangelands and their ecosystem services are often caused by an inappropriate management and land use that do not account for ecological suitability. In arid and semi-arid rangelands, where precipitation is highly erratic, the need for sustainable land-use strategies has a paramount importance.

The two major environmental stressors in rangelands, which limit grass productivity, are rainfall and herbivory. Understanding effects of these stressors on individual grass species requires controlled studies of the two influencing factors on grass productivity. Such understanding has been hampered by the difficulty of quantifying below-ground biomass; so far, little experimental research has been conducted on this aspect. We experimentally quantified above- and below-ground biomass and C content of two selected native, perennial grass species in pots and field trials to see effects of variable rainfall amount (irrigation) and grazing frequency (clipping) in Borana rangelands, southern Ethiopia.

Clipping significantly decreased above-ground biomass (agB) and above-ground organic carbon (agOC) compared to unclipped grass tufts in both *Chloris gayana* (P = 0.0001) and *Cenchrus ciliaris* (P < 0.0001); on the other hand, below-ground grass biomass (bgB) and organic carbon (bgOC) was significantly higher (P = 0.0303) in clipped tufts than in unclipped ones. When we combined clipping and irrigation, both factors significantly influenced agB and agOC; limited irrigation, however, resulted in significantly lower bgB and bgOC. Interactions between the two factors were observed only in the pot experiment of *C. gayana* affecting both bgB and bgOC.

Our study indicated that both grazing frequency and rainfall amount significantly influenced grass productivity and C allocation potentials. This implies that unless appropriate grazing management is in place, the potential of grasses to sequester C and store it in biomass and soil will be greatly limited by existing herbivore pressure and high variability of rainfall amount in the course of climate change.

O5 - Effects of landscape structures on rice agro-ecosystem biodiversity and biological control across the Philippines

Christophe Dominik[1], Tomáš Václavík[1], Finbarr Horgan[2], Josef Settele[3], Ralf Seppelt[1]

[1]Helmholtz Centre for Envionmental Research - UFZ, Leipzig, DE, christophe.dominik@ufz.de
[2]International Rice Research Institute, Los Baños, PH
[3]Helmholtz Centre for Envionmental Research - UFZ, Halle, DE

In the Asian rice agro ecosystems, pests like the brown planthopper (BPH) and the white-backed planthopper (WBPH) are major threats to rice production, causing significant yield loss. The misuse of pesticides in rice production destroys the natural biocontrol mechanisms because natural enemies are just as susceptible to the pesticides as the pest.

While it is hypothesized that habitat diversity and landscape complexity can enhance natural enemy populations and thus benefit crop production by reducing pests, the effects of landscape structure in rice agro-ecosystems are largely unknown.

This study aims to test the potential influence of landscape complexity on the distribution of specific species representative for the given predator-prey system. We use a landscape ecology approach to examine the effects of spatial configuration and temporal land use regimes on the distribution of rice pests and pest-controlling species at a regional scale.

Landscape composition and configuration affect guild composition and species richness of the arthropod community but responses varied with taxa. The two main pests of rice (BPH and WBPH) respond differently to the landscape structures, but in general, overall arthropod species richness decreased with the area of rice fields in the landscape.

Better understanding the role of landscape complexity in biological control will benefit crop production and result in increased sustainability of the farming system. Protection of non-crop habitats can also enhance a range of cultural services such as the aesthetic value of the landscape, cultural heritage and eco-tourism.

O6 - Birds and bats affect multitrophic interactions and crop yield in cacao agroforestry landscapes

Bea Maas[1], Yann Clough[1,2], Teja Tscharntke[1]

[1]Agroecology, University of Göttingen, Göttingen, DE, beamaas@gmx.at
[2]Centre for Environmental and Climate Research, Faculty of Science, Lund University, Lund, SE

Tropical landscapes are increasingly fragmented and dominated by agricultural expansion, sustainable landscape management therefore requires improved understanding and management of the functional relationship between natural resources and human welfare. We investigated the interrelation of birds, bats, arthropods and crop productivity in differently managed cacao agroforestry systems in Central Sulawesi (Indonesia).

Exclosure experiments of birds and bats in 15 differently shaded cacao agroforestry systems were conducted over 20 months in combination with day- and night-time arthropod surveys, bird predation experiments, and the investigation of crop yield quantity and quality. Unlike previous studies, we investigated the effects of vertebrate predation along local management (shade cover) and landscape (distance to primary forest) gradients.

Our results highlight the tremendous economic impact of common insectivorous birds and bats which support cacao crop yield productivity by 31% across local and landscape gradients, corresponding to an economic value of 730 USD per ha and year. Herbivore abundance increased, despite the concurrent release of mesopredators such as ants and spiders. Avian predation success increased with increasing forest proximity and turned out to be driven by the common Lemon-bellied White-eye (e.g. *Zosterops chloris*) rather than by overall species diversity.

These findings demonstrate the importance of landscape structure for both ecosystem services and functional diversity, although they do not necessarily depend on the same local management strategies and might be of different importance for smallholder economics and conservation aspects. To contribute to sustainable agroforestry management on a landscape scale, both ecosystem services and functional diversity need to be taken into account.

O7 - Allometric assessment and natural regeneration of Spondias tuberosa Arr. Câm. in different land use

Déborah Oliveira[1,2], Jarcilene Almeida-Cortez[2], Gleicy Gonçalves[2], Maik Pommeranz[1], Arne Cierjacks[1]

[1]University of Hamburg, Hamburg, DE, deborahalani@gmail.com
[2]Universidade Federal de Pernambuco, Recife, BR, deborahalani@gmail.com

Spondias tuberosa Arr. Cam. is an endemic fruit-bearing tree of the Brazilian semi-arid region with great socioeconomic and environmental importance. However, there is a lack of seedling recruitment in their natural environment, which has been attributed to seed predation, the low seed germination and establishment, and the irregularity of rainfall in the region. Furthermore, land use change and overexploitation have been hypothesized to cause a risk of extinction in this species. In this study, we aimed to assess the population structure and the natural regeneration of *S. tuberosa* in areas with different land use options. We selected 75 individuals in three municipalities in Northeast of Brazil and classified each tree locations in: agricultural area, degraded caatinga, severely degraded caatinga and preserved caatinga. From each tree, we measured height, canopy and stem diameter. In addition, we counted seeds, seedlings and goat feces and classified the trees in six diameter classes. In the study area, *S. tuberosa* seedlings were nearly completely absent. We found seedlings exclussively in agricultural areas, probably due abundance of water and absence of wild or domesticated animals. Moreover, the number of seeds per m² was higher in this area. The highest rate of trees characterized by a small diameter was identified in preserved caatinga but as in the other áreas trees smaller than 22 cm in diameter which corresponds to a trees age of about 20 years occured only exceptionally. The highest impact of land use on the population structure was found in degraded caatinga. Interestingly, grazing intensity as indicated by the amount of goat feces did not correspond to the land use categories based on stem numbers as highest amount of feces was found in preserved caatinga. This result implies that grazing pressure by goat does not influence the regeneration of *S. tuberosa* and other factors linked to land use seem to alter the population dynamics in this species.

O8 - Conservation and Utilization: The greenhouse gas balances of paludiculture on two rewetted peatlands do not differ from pristine systems

Anke Günther[1], Vytas Huth[1,2], Gerald Jurasinski[1], Kerstin Albrecht[1], Stephan Glatzel[3]

[1]Landscape Ecology, University of Rostock, Rostock, DE, anke.guenther@uni-rostock.de

[2]Leibniz Centre for Agricultural Landscape Research (ZALF), Müncheberg, DE
[3]Department of Geography and Regional Research, University of Vienna, Vienna, AT

In Europe, rising prices for farm land make it increasingly difficult for conservationists to compete with external investors during the acquisition of land for wetland restoration. Thus, adding economic value to these areas by combining extensive land use with nature conservation efforts could increase the amount of ground available for wetland restoration. The concept of paludiculture aims to provide biomass for multiple purposes from peatlands with water tables high enough to conserve the peat body. However, as plants have been shown to contribute to greenhouse gas exchange in peatlands, manipulating the vegetation (by harvesting, sowing etc.) might alter the effect of the restored peatlands on climate. Here, we present greenhouse gas data from two experimental paludiculture systems on formerly drained intensive grasslands in northern Germany. In a fen that has been rewetted more than 15 years ago three species of reed plants were harvested to simulate biomass production for bioenergy and as construction material. And in a peat bog that has been converted from drained grassland to a field with a controlled water table around ground surface Sphagnum mosses were cultivated to provide an alternative growing substrate for horticulture. In both systems, we determined carbon dioxide, methane, and nitrous oxide exchange using closed chambers over two years. Both restored peatlands show greenhouse gas balances comparable to those of natural ecosystems. In the fen, fluctuations of the emissions reflect changes in weather conditions across the study years. We did not find a negative short-term effect of biomass harvest or Sphagnum cultivation on net greenhouse gas balances. Therefore, paludiculture may likely provide a possibility to add economic value to restored peatlands while retaining the positive effects of rewetting for greenhouse gas mitigation.

O9 - Rubber plantations as repositories for endangered plant species? A case study from SW China.

Gerhard Langenberger[1], Georg Cadisch[1],Konrad Martin[1]

[1]University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Hohenheim, DE, langenbe@uni-hohenheim.de

In the last decade Mainland Southeast Asia experienced a tremendous expansion of natural rubber (NR) acreage, mainly at the expense of diverse traditional land use types or forests. Since NR is usually managed as monoculture, often rigorously clean weeded, the development took its toll on biodiversity. This raises the question how to protect rare and endangered species in an originally highly diverse but now homogenized landscape. A discussion on ‘land sparing’ versus ‘land sharing’ is often idle since there is nothing left to spare. Therefore, the question arises if rubber plantations themselfes can be used to protect at least some selected species. But such an approach faces considerable challenges, being presented in this talk, which is based on the experience with the integration of protected species in a demo-site of the SURUMER-project (Sustainable Rubber Management in the Mekong Region: www.surumer.uni-hohenheim.de) in Xishuangbanna, Yunnan Province, SW China.

O10 - Assessing the impact of forest-to-rubber conversion: land use carbon dynamics and its ecosystem service benefit evaluation

Xueqing Yang[1,2], Sergey Blagodatsky[1], Jianchu Xu[3], Georg Cadisch[1]

[1]University of Hohenheim, Stuttgart, DE, yangxueqing@mail.kib.ac.cn
[2]Kunming Institute of Botany, CAS, Kunming, CN, yangxueqing@mail.kib.ac.cn
[3]World Agroforestry Centre, Kunming, CN

In the tropical region of China, the major driver of deforestation is conversion of land to rubber plantations. This is a trend across much of South East Asia. At present, rubber plantations in montane mainland Southeast Asia cover an area of more than 1.5 million ha of which 424,000 ha are located in the prefecture of Xishuangbanna. High rate of rubber expansion already creates threaten to local ecosystem service and benefit, such as carbon flux, erosion control, nutrient cycling and biodiversity. Current study was conducted in Naban National Nature Reserve (NNNR), Xishuangbanna to evaluate the impact of land use change on carbon stock by using RaCSA method (Rapid Carbon Stock Appraisal). Within NNNR, four dominant land use systems are surveyed, namely natural forest, rubber plantation, agricultural crops, bush and grassland. The time averaged above ground carbon stock was applied for large scale upscaling. Time series of land use and land cover maps (1989, 2007 and 2012) were compared for carbon stock changes evaluation. Finally the ecosystem service values for different land use types also estimated. The results showed: 1) the time averaged above ground carbon stock of highland and lowland rubber plantation was 118.02 Mg C ha^{-1} and 49.29 Mg C ha^{-1} respectively, which showed more carbon sequestration potential than agricultural crops, bush and grassland but still lower than highland and lowland forest; 2) from 1989 to 2012, lowland rubber expansion rate in buffer zone was 22.78 ha yr^{-1} and in experimental zone was 15.38 ha yr^{-1}, while highland rubber expansion rate was 21.15 ha yr^{-1} and 50.78 ha yr^{-1}, core zone was not influenced by rubber cultivation; 3) During 23 years land use change, the whole landscape of Nabanhe gained 0.64 Mt C sequestration value, with a rate of 24.12 Mg C ha^{-1} $year^{-1}$; 4) the estimated ecosystem service value of all land use types increased 5.715 US $ Million, it mainly comes from high land regeneration of forest from bush and grassland, although lowland deforestation showed decreased ecosystem service of 1.483 US $ Million. The result of this study could be used for guiding sustainable land use management at regional scale.

Keywords: forest-to-rubber conversion, Rapid Carbon Stock Appraisal (RACSA), land use change, time averaged carbon stock, ecosystem service values

O11 - Earthworm bioturbation stabilizes carbon in non-flooded tropical paddy soil

Katharina John[1], Frank Jauker[1], Juergen Marxsen[1], Andrei S. Zaitsev[1], Volkmar Wolters[1]

[1]Justus Liebig University, Department of Animal Ecology, Heinrich-Buff-Ring 26-32, D-35392 Giessen, DE, Katharina.John@allzool.bio.uni-giessen.de

Being among the most important soil engineers, the potential of earthworms to beneficially affect carbon storage and cycling in tropical rice-based ecosystems is poorly understood, as most studies are biased towards their perception as pests. We carried out a microcosm experiment to quantify the impact of a tropical earthworm on C turnover in paddy soils under the combination of two gradients: soil water saturation and nitrogen fertilizer intensity. The paddy soil was collected at the International Rice Research Institute (Philippines). Half of the microcosms received a single individual of *Pheretima* sp. Soil CO_2 and CH_4 evolution was measured for 5 consecutive days. At the end of the experiment, the activity of five extracellular enzymes was assessed and bacterial abundance was quantified.

Earthworms suppressed both, a nitrogen-induced increase of CO_2 as well as the distinct CO_2 respiration maximum at intermediate soil water saturation. However, the earthworm treatment resulted in a strong increase of CH_4 release under flooded conditions. Activities of alpha-glucosidase, beta-xylosidase, phosphatase and leucine-aminopeptidase (but not of beta-glucosidase) as well as bacterial abundance generally were not consistently affected by nitrogen input or earthworm treatments.

Our findings suggest that the potential role of earthworms in C-stabilization is confined to moderately irrigated soils that allow high earthworm activity. Under conditions of intensive agriculture, the stabilizing effect of the worms may even be augmented by the fact that they offset the positive effect of N fertilization on microbial respiration. Earthworms may thus play a vital role in reducing the CO_2 flush from paddy soils after the conversion to non-flooded crops such as aerobic rice or maize. However, accelerated CH_4 release in submerged soils induced by earthworms points to a certain risk that is associated with increasing earthworm population in production systems that are still exposed to flooding.

O12 - Contribution of invertebrates to rice straw decomposition in crop rotations with different water regimes

Anja Schmidt[1], Katharina John[2], Harald Auge[1,3], Roland Brandl[4], Finbarr Horgan[5], Josef Settele[1,3], Volkmar Wolters[2], Andrei S. Zaitsev[2], Martin Schädler[1,3]

[1]Helmholtz-Centre for Environmental Research – UFZ, Halle (Saale), DE, a.schmidt@ufz.de
[2]Justus-Liebig-University Gießen, Giessen, DE
[3]iDiv, German Centre for Integrative Biodiversity Research, Halle-Jena-Leipzig, Leipzig, DE
[4]Philipps-Universität Marburg, Marburg, DE
[5]International Rice Research Institute, Los Baños, Metro Manila, PH

Rice is one of the most important food resources in the world. Due to the increasing food shortage, especially in Southeast Asia, alternative methods in rice agriculture are increasingly in demand. The conversion of permanently flooded rice growing into cropping systems including non-flooded upland crops is an innovative approach to increase yields as well as to decrease the high water consumption and greenhouse gas emissions of paddy fields. Up till now, little is known about the effects of the shorter flooding periods on the established below ground communities, especially on decomposer invertebrates. Therefore, we conducted an experiment in the lowlands of the Philippines which aimed at assessing the impacts of different crop rotations on litter decomposition by invertebrates in relation to soil community structures. Fieldwork took place at 36 plots of the ICON field experiment where we set rice straw filled litterbags of two different mesh sizes that prevent (20 × 20 µm) or allow (5 × 5 mm) access of invertebrates. The field design included four different crop rotations (dry - wet season): aerobic rice - wet rice; maize - wet rice; maize - aerobic rice; and monocultures of flooded rice. Litterbags were set into the upper part of the soil shortly after transplanting or seeding of the crops and retrieved after 72 days in both seasons in 2013. Further, soil core samples were taken to examine the micro- and mesofauna within the soil. Our results show that under anaerobic soil conditions invertebrate decomposers significantly increased litter mass losses while microbial decomposition rates were rather low. Vice versa, aerobic soil conditions triggered the decomposition rates of microorganisms while invertebrates showed no significant contribution to the decomposition of the rice straw. The water regimes of the different crop rotations affected the soil community as well, with significantly higher abundances of mesofauna groups during dry field conditions. No direct relationships were detectable between the abundances of the recorded soil fauna groups and the contribution of invertebrates to rice straw decomposition. Our results show that invertebrates significantly influence rice straw decomposition in flooded paddy fields. In wet-dry cropping systems they compensate the reduced microbial decomposition rates under the anaerobic soil conditions during the wet season while rice straw decomposition during the dry season is mostly driven by microorganisms.

P1 - Epiphytes in human-modified landscapes: dispersal and establishment

Helena JR Einzmann[1], Gerhard Zotz[1,2]

[1]Carl von Ossietzky Universität, Oldenburg, DE, helena.einzmann@uni-oldenburg.de
[2]Smithsonian Tropical Research Institute, Panama, PA

The original plant cover of Central and South America is increasing affected by disturbance and large-scale land use changes due to demand for agricultural production, logging, hunting, and mining. Although it seems inevitable that increasing human populations lead to increasing modification and fragmentation of native vegetation, there is an ongoing discussion whether slowing human population growth and intense urbanization may result in a slowdown of deforestation and an acceleration of natural forest regeneration through secondary succession. The structure and composition of such secondary forests will strongly depend on the available biotic components currently in place. Vascular epiphytes constitute a major component in forests in topical latitudes. Based on an inventory of epiphytes on trees in different types of secondary vegetation in lowland Panama we studied the viability of existing populations and the connectivity of patches by testing experimentally four different steps of successful dispersal: seed falling velocity of orchid and bromeliad seeds as a proxy of long distance dispersal potential, the ability of bromeliad seeds to stick to different bark types, germination and early establishment of bromeliad species on trees in pastures, plantations, and forest fragments. Low seed falling velocity suggests very high potential for long distance dispersal. Seed adherence did not differ with habitat type nor did germination and early survival, but the latter strongly correlated with annual rainfall. Together with the results of repeated censuses in the study area, our results suggest that current epiphyte assemblages in human-modified landscape are indeed viable and may be of considerable importance for the restoration of diverse tropical forests if secondary forests may be allowed to develop as predicted.

P2 - A Qualitative Thematic Analysis Approach on Mapping Landscapes' Capacities to Supply Ecosystem Services in Sabah, Malaysia

Kamlisa Uni Kamlun[1,2], Bürger Arndt Renate[1]

[1]Faculty of Forest Sciences and Forest Ecology Goettingen University, Goettingen, DE, unikamlun@gmail.com
[2]Faculty of Science and Natural Resource, Universiti Malaysia Sabah, Sabah, MY, unikamlun@gmail.com

Convention of Biological Diversity in Japan (2010) recommends assessment of ecosystem services(ES) to value nature by non-monetary approaches. Non-monetary assessments are very few although standardised approaches to quantify ecosystem services are required. Pertinent to that, holistic appraisal on ES of various land cover types on the landscape scale must be taken into account. In order to transfer the ES concept to landscape planning, integrated and easily applicable assessment approaches of mapping ES using 'Matrix Model' to assess landscapes capacities was introduce. However, poor methodological transparency, comparably low reproducibility and lack of appropriate uncertainty acknowledgement made the matrix model a risky tool for actual decision support. Every uncertainty in the data translates to an increased risk for undesired outcomes for decision makers. Therefore, the purpose of this study is to develop transparent analysis of assessing ES supply capacities in a bundles of tropical wetland landscape. Multitemporal supervised classification using satellite images were used to extract different land cover/land use types as complex indicators. Thematic analysis of a structured literature search using systematic and consistent assessment was performed using ScienceDirect, Google Scholar, Science Citation Index, Scopus and Grey Literature to identify the

capacities of ES supply indicator. Then, the quality and reliability of the indicator identified was then validated through expert interview using Delphi technique.Matrix model using Likert scale was then use to translate the land cover map into a map of potential ES supply using GIS spatial analyst. Result shows that the locations of respective ES supply in a bundle of landscape were determine at a local scale. It was also revealed that the capacities of different land cover type change over time under the pressure of human activities. We also presented a systematic analysis to extract expert information on ES supply capacities for each land cover type using Matrix Model. The result derived from this study demonstrate an innovative approach to non-monetary valuation of tropical wetland ecosystem services supply. In addition, it can be used to monitor and develop wetland management goals in formulating effective policies with regards to human well-being.

P3 - Do different management strategies in heathlands lead to different phylogenetic patterns?

Ina Geedicke[1]

[1]Universität Hamburg, Hamburg, DE, ina.geedicke@gmail.com

Species richness is a widespread measure to evaluate the effect of different management types on biodiversity in ecosystems. However, analyzing the phylogenetic structure of plant communities could provide new insights into the effects of different management methods on the phylogenetic community assemblages and provide further guiding for conservation decisions.

German heathlands require permanent management to ensure the existence of this cultural landscape. While traditional management with sheep is time consuming, mechanical methods are applied often and the consequences to the phylogenetic community assemblages are unclear. In this thesis, several phylogenetic measures were calculated for vascular plant, bryophyte and lichen communities in five different management types: fire, plaggen, mowing, deforestation and intensive grazing. To analyze the effect of the management types to all taxonomic groups, a comprehensive phylogenetic tree was created consisting of all vascular plants, bryophytes and lichen encountered at the study site.

The results showed that the deforested areas supported significantly higher phylogenetic diversity values for all taxonomic groups. A phylogenetic clustering in lichen community was observed using the mean pairwise diversity (MPD) and the mean nearest taxon diversity (MNTD). Management by mowing and intensive grazing promotes habitat filtering of lichen, while more disturbing management types such as fire and plaggen do not support a phylogenetic pattern.

While deforestation is the oldest management method to establish heathlands, it also contains the most diverse habitat for plants and lichen. However, the deforested areas do not represent the typical picture of heathlands that is sought by tourism. Therefore, a management strategy based on small scale deforestation, to ensure a high variety of plants and lichen, intensive grazing, plaggen and mowing would support the maintenance of heathlands. A heathland which does not exclusively contain the typical heather plants but also a high number of lichen and bryophytes.

P4 - Species richness and complementarity of herbaceous angiosperms along an elevational gradient in Central Veracruz, Mexico

Jorge Antonio Gómez Díaz[1], Thorsten Krömer[2], Gerhard Gerold[1], Felix Heitkamp[1]

[1]Georg-August-Universität Göttingen, Göttingen, DE, jgomezd@gwdg.de
[2]Universidad Veracruzana, Xalapa, MX

The state of Veracruz hosts a high diversity of herbaceous angiosperms, a plant group that is threatened by land use changes and shows a lack of knowledge. For these reasons, we realized a study on this group in central Veracruz, Mexico, along an elevational gradient at the slopes of the volcano *Cofre de Perote* between 40 and 3,520 m. The aim was to compare species richness and similarity between different elevational belts and vegetation types. In total, 136 plots of 20 x 20 m (total area: 5.4 ha), distributed in natural, azonal, disturbed and secondary vegetation were sampled in the localities of: *La Mancha* (40 m), *Palmarejo* (500 m), *Chavarrillo* (1000 m), *Los Capulines* (1500 m), *El Zapotal* (2000 m), *El Encinal* (2500 m), *Los Pescados* (3000 m) and *El Conejo* (3500 m). We recorded a total of 252 herbaceous angiosperm species in 142 genera and 52 families. This richness represents 3.7% of the taxa of Veracruz' angiosperm flora. We found 30 endemic species to Mexico, one to Veracruz and three classified as threatened on country level. The most species-rich families are Poaceae (36), Asteraceae (29) and Orchidaceae (23), whereas the most important genera are *Peperomia* (10), *Salvia*, *Begonia* and *Cyperus* (8 each). To compare the disturbance effect at elevational belts, we used the values of α (richness per plot), β (1-Sørensen) and γ (total richness) diversity. In the first case, there was no difference between habitats concerning disturbance, but there were significant differences between the altitudinal belts with the highest species richness found at 2500 and 3000 m. In the second case, there were significant differences between habitats that showed an increase in β diversity with disturbance but there was no effect of altitude. In the third case, in general, there was an increase of richness with disturbance and the belts with the highest species richness are 2500, 1500 and 3000 m. We found a not very pronounced hump-shaped pattern in species distribution, which is a typical pattern found in various plant groups in the tropics. This demonstrates that the disturbance can affect the richness of herbaceous angiosperms in different ways and can lead to different species compositions. In conclusion, for this group disturbance and altitude promote the competition for new niches and an increase in diversity.

P5 - Bird diversity in an agro-ecosystem in the Northern Limpopo Province of South Africa

Steven Evans[1]

[1]University of Venda, Thohoyandou, ZA, stevenwe@vodamail.co.za

Birds have been used as indicators of environmental change such as climate change, environmental pollution and habitat loss. The aim of this project was to determine how bird communities are affected by different resource uses in an agro-ecosystem. The study was conducted in three broadly delineated habitat types 1) residential area (Vyeboom village), 2) abandoned fields and 3) least modified area. Three timed transect counts (TTC), per habitat and per season (Summer 2015 and Winter 2014), were walked, each lasting three hours. All birds seen and heard within a distance of 100 m either side of the transect route were included in the survey. The residential area contained a significantly larger number of individuals (Summer: $X^2_2 = 278$, $p < 0.01$, Winter: $X^2_2 = 350$, $p < 0.01$) of significantly fewer species (Summer: $X^2_2 = 14$, $p < 0.01$, Winter: $X^2_2 = 11.8$, $p < 0.01$) compared to the other two habitats. In Summer ($X^2_2 = 14.7$, $p < 0.01$) and Winter ($X^2_2 = 10.3$, $p < 0.01$) the least modified area and abandoned fields contained significantly more species of carnivorous birds compared to the residential area (n = 22 and 19 respectively). Bird species feeding and nesting in trees and shrubs were less common in the residential area as it contained significantly fewer indigenous trees ($X^2_2 = 53.5$, $p < 0.01$), and, small trees and shrubs ($X^2_2 = 10.4$, $p < 0.01$) compared to the other two habitats. Disturbance of birds by people in the residential area accounts for the lower number of ground nesting birds here compared to the other two habitats. The expansion of maize fields and wood extraction in the abandoned fields is predicted to result in this areas bird community more closely resembling what is currently observed in the residential area. The continued grazing and extraction of wood from the least modified area will ultimately result in this areas bird community more closely resembling what is currently observed in the residential area.

P6 - From roadside to the forest interior: How does plant composition change in Caspian forests?

Agrin Badami[1], Ehsan Abdi[1], Lutz R. Eckstein[2], Zahed Shakeri[3]

[1]Faculty of Natural Resources, university of Tehran, Karaj, IR, agrbadami@gmail.com
[2]Institute of Landscape Ecology and Resource Management, Research Center for Biosystems, Land Use and Nutrition (IFZ), Justus Liebig University Gießen, Giessen, DE
[3]Faculty of Natural Resources, University of Kurdistan and the Center for Research & Development of Northern Zagros Forestry, Sanandaj, IR

Forest roads are among the most important preconditions for management of forest ecosystems. The Kheiroud investigation forest, Northern, Iran has about 50 kilometers of road network since 1960. In order to evaluate the ecological effect of

forest roads on adjacent vegetation, we selected a part of the main branch of this road network (22 km). Vegetation sampling was carried out using 22 transects, placed at two kilometer distances, perpendicular to the road axis. In each transect, six sample plots (2×10 m) were placed at 0, 5, 10, 25, 50 and 100 meters form road edge (132 plots in total). In each sample plot, environmental variables and vegetation data were collected in April-May 2013. TWINSPAN, indicator species analysis and direct ordination (CCA) were used to analyze the effect of road and environmental variables on vegetation composition. Among 100 plant taxa recorded, 20 species have been found only in roadside sites. The TWINSPAN run resulted in seven distinct groups. The first group consists of 19 plots, with *Mentha aquatica* as the main indicator species, merely belonging to adjacent and wet roadsides (zero distance to the road). Indicator species analysis also resulted in 26 species, among them 23 species represented zero distance from the road side, one species (*Ulmus glabra* seedlings) represented 10 meters and two species (*Epimedium pinnatum* and *Euphorbia amygdaloide*) represented 100 meters distance from the road edge. Forward selection in CCA analysis resulted in 10 significant variables out of the initial set of 38 variables. Among them; zero distance from the road, litter depth, relative light intensity, inclination, elevation and forest type had the most influence on plant composition (22.44 % of total variation). Our result show that roads can change vegetation composition up to 10 meters distance from the road edge, promoting light demanding, ruderal and exotic plants like *Mentha aquatica*, *Equisetum telmateia*, *Rumex sanguineus*, *Prunella vulgaris*, *Sambucus ebulus*, *Paspalum paspaloides* and *Microstegium vimineum* in the Caspian forests.

P7 - Ex-situ performance of the European globeflower (Trollius europaeus L.) from seeds of populations from different grassland scenarios

Tamina Wosch[1], Andreas Titze[2], Birgit Ziegenhagen[1], Norbert Kowarsch[3]

[1]University of Marburg, Marburg, DE
[2]Botanical Garden of Marburg University, Marburg, DE
[3]Bundesanstalt für Landwirtschaft und Ernährung, Bonn, DE

The globeflower populations of Central Europe are more and more declining mainly due to an intensified grassland use. Globeflowers require moist habitats with annual or biennial mowing, which is mainly represented by an extensive use of grasslands. Since 1996 globeflower populations in the „Rothaar-Mountains“ are monitored and an *ex-situ* - *in-situ* conservation management has been launched where the Botanical Garden of the University of Marburg is playing a key role. In the present study we are analyzing the *ex-situ* performance of globeflowers which have been raised from seeds collected from stands with three different grassland scenarios. These are extensive pastures, mowing meadows and fallow land and are represented with each two repetitions within a common garden experiment in the Botanical Garden. The outcome of our study will serve two purposes. First, we will test the hypothesis that progeny from populations of intensively used grasslands have a comparably poor performance while performance is taken as surrogate for fitness. Next, the Garden will constitute a protocol for raising and qualifying the *ex-situ* material for re-introduction purposes. Results are discussed and follow-up strategies suggested such as accompanying the management by population genetic analysis.

P8 - Establishment of Nothofagus obliqua, N. glauca and Quillaja saponaria in the Mediterranean Zone of Chile - a case study

Carolin Stiehl[1], Steffi Heinrichs[1], Burkhard Müller-Using[2], Christian Ammer[1]

[1]University of Göttingen, Department of Silviculture and Forest Ecology of the Temperate Zones, Göttingen, DE, cstiehl@gwdg.de
[2]Universidad de Concepción, Facultad de Ciencias Forestales, Concepción, CL

Forestry in Chile mainly focuses on plantations with exotic species such as *Eucalyptus* spec. and *Pinus radiata*. Most of these plantations are located in the Mediterranean Zone due to fertile soils and high solar radiation. In Chile there is little experience with management of native species and only few studies exist concerning their establishment. Our study aimed to examine the establishment phase of three Chilean tree species that are native to the Mediterranean Zone - the deciduous *Nothofagus obliqua* and *Nothofagus glauca* and the evergreen *Quillaja saponaria* - and to give suggestions for management of these native species as an alternative to plantations with exotic species.

We asked the following questions: 1.) Which degree of thinning is reasonable for a successful establishment of *Nothofagus obliqua*, *Nothofagus glauca* and *Quillaja saponaria*? 2.) Does light availability explain height and diameter growth of the examined species sufficiently? 3.) In which phase of the vegetation period do these plants have the highest growth increment? 4.) Which is the species best adapted to the site conditions?

The study was conducted in the Central Zone of Chile (VIII. Region) in the Province of Quirihue under an overstory gradient. The climate is Mediterranean with oceanic influence. We chose 36 saplings of each species. Shoot length, stem diameter, soil moisture, stomatal conductance, leaf traits and climate data were measured five times within one vegetation period (October 2012 to May 2013). Light availability (Indirect Site Factor) was measured once with fully foliated overstory.

The preliminary results support the hypothesis that light availability is the crucial factor in growth increment of the three species. Increment was highest at a range of 70-90% light availability for all three species. Length and diameter growth was highest in the spring and early summer period of November to January for all species. *Nothofagus obliqua* had the highest increment of the three species. Silvicultural implications of these results will be discussed.

P9 - Partial cuts in paludified boreal forests: effects of harvest operations and site conditions on regeneration recruitment and growth

Raphaële Piché[1], Alain Leduc[1], Yves Bergeron[1,2]

[1]Université du Québec à Montréal, Montreal, CA, piche.raphaele@courrier.uqam.ca
[2]Université du Québec en Abitibi-Témiscamingue, Rouyn-Noranda, CA

In Canada's boreal forest, careful logging, a type of total cut that leaves in place pre-established regeneration (known as CPRS in the province of Quebec), is the most common form of wood harvesting. In order to maintain long-term wood supply, the main goal of this logging method is to ensure a healthy regeneration in sufficient numbers. Total cuts are problematic in many aspects and are replaced in certain areas with less-destructive partial cuts. However, the effects on regeneration of both types of logging in limited-productivity sites such as paludified northwestern Quebec are still unknown. To determine whether site conditions or the type of harvest influence regeneration success, this study looks at the recruitment and growth of tree regeneration 10 years after partial cuts and CPRS in the northern black spruce-feathermoss forest of Abitibi (Quebec). Our results demonstrate that seedling recruitment was determined by the presence of good-quality establishment substrates, more specifically *Sphagnum sp*. ground cover, light availability and the quantity of mature seeding trees. Recruitment was negatively impacted by competitors (i.e. *Rhododendron groenlandicum*). The logging treatment (CPRS or partial cut) had an ambiguous effect on recruitment. There was a better recruitment in protection strips in between skid trails of both type of logging methods for seedlings larger than 15 cm, but this trend was not observed for the smaller seedlings. Seedling growth was influenced by light availability and soil organic matter depth, a measure of paludification. In general, there is enough regeneration to insure a long-term supply of wood, but more information on seedlings growth limitations is necessary to formulate concrete recommendations.

P10 - Avifaunistic Change From a Gravel Pit to a Frequently Disturbed Riparian Forest in Duisburg

Stefan Hohnwald[1]

[1]Landscape Ecology, Georg-August-University of Göttingen, Göttingen, DE, shohnwa@gwdg.de

Riparian forests of the Lower Rhine in Germany have been early deforested and converted, for instance into pastures, many centuries ago. Thus, there were hardly mature natural riparian forests left and consequently knowledge about its biodiversity is still poor and insecure. However, the small conservation area "Werthauser Wardt" in Duisburg, set up in 1989 for the protection of local and migrating waterfowl along the Rhine, is one rare example of a White Willow softwood forest that has been developed from a flooded gravel pit into a closed forest in the last dec-

ades. However, neither the typical bird fauna nor the succession have been documented until now for the Lower Rhine. Therefore, the purpose of this study is to summarize audiovisual bird surveys done between November 1997 and August 2011 for ecological evaluation. Sixty daily check-lists of similar field trips were evaluated and compared with earlier single records of the same area and with the theoretical potential natural avifauna of White Willow riparian forests. In total, 102 bird species (69 genera, 31 families) were registered during the study. The conservation area offers one of the last adequate biotopes for the southernmost breeding population of Eurasian Oystercatcher and Common Shelduck at the Lower Rhine. Pioneer bird species as Little Ringed Plover, Common Tern, and Eurasian Stone-Curlew disappeared, while Eurasian Penduline Tit, Eurasian Golden Oriole, Middle Spotted Woodpecker, and Black Kite are still missing. Despite the frequent impact of disturbances by sport anglers and walkers with dogs, the area is worth protecting as a small stepping stone for migrating and wintering waterfowl along the Rhine and should be better cared for by all visitors and stakeholders.

P11 - Ecological impacts of simulated historical tree litter offtake on forest understory vegetation

Ondřej Vild[1,2], Jesse Kalwij[1,3,4], Radim Hédl[1,5]

[1]Institute of Botany, Department of Vegetation Ecology, The Czech Academy of Sciences, Brno, CZ
[2]Masaryk University, Department of Botany and Zoology, Brno, CZ
[3]Institute for Ecosystem Research, Geobotany, Kiel University, Kiel, DE, jkalwij@ecology.uni-kiel.de
[4]DST-NRF Centre of Excellence for Invasion Biology, Department of Zoology, University of Johannesburg, Johannesburg, ZA, jkalwij@ecology.uni-kiel.de
[5]Department of Botany, Faculty of Science, Palacký University, Olomouc, CZ

Subsistence tree litter offtake was once a widespread activity in the woodlands of central Europe. Here, we experimentally tested the impact of tree litter offtake on the understory vegetation in a temperate deciduous forest, and we determined the role of seasonal timing of tree litter offtake. The experiment was conducted a deciduous forest stand in Podyjí National Park, Czech Republic. We used a randomized complete block design of 45 plots. Each block (N = 15) consisted of three plots (5 × 5 m); one for each treatment namely: (i) litter offtake during spring, (ii) litter offtake during autumn, or (iii) no litter offtake as control. We applied these treatments annually for a duration of four years. We recorded the understory plant species composition, and collected soil samples, for each plot prior to the start of the experiment (year 0), and in each subsequent year (years 1–4). We analysed temporal trends in species richness using repeated measures ANOVAs. In addition, we used Principal Response Curves to analyse the impact of treatment on species composition over time. The species richness of annuals increased significantly, but only for autumn treatment. Annual species also showed highest inter-annual varia-

tion. While the total species richness significantly changed over time, this was not related to treatment. Endangered species were not affected by any treatment. The impact of autumn raking on species composition was stronger than the effect of spring raking, when compared to the control treatment. Although nutrient offtake greatly exceeded ambient nitrogen intake, we detected no change in soil conditions. We detected a small yet significant effect of the season in which tree litter offtake took place on the understory vegetation, in particular on the germination and establishment of annuals. Large inter-annual variation in species richness suggests that a continuation of the field experiment is justified. Nutrient offtake via litter raking greatly exceeded atmospheric nutrient deposition, warranting a further investigation of litter raking as a potential tool for forest conservation.

P12 - A multiple scale study to explore the role of secondary forests in extending tropical dry forest species population in India, Asia

Vijayalaxmi Kinhal,[1], Martin Wiesmair[1,2], Rainer Waldhardt[1,2]

[1]Division of Landscape Ecology and Landscape Planning, Institute of Landscape Ecology and Resource Management, Justus-Liebig University, Giessen, DE, vijayalaxmi.kinhal@umwelt.uni-giessen.de
[2]Center for International Development and Environmental Research, Justus-Liebig University, Giessen, DE

The role of secondary forests in aiding persistence of primary species outside protected tropical dry forests (TDFs) is increasingly receiving attention, as most of the TDFs are fragmented and degraded.
In a landscape scale study, we will empirically test receiver and donor connectivity in fragmented TDFs. Previously nurse-plants amelioration of abiotic factors had proven to facilitate primary forest species at mirco-site scale. We will examine if scrubs/secondary forests formed by the nurse plants in the surrounding matrix of primary forest fragments act as stepping stones and extend the population of forest species at landscape scale. The research will be conducted in the densely populated Coromandel coast of India, where fragments of tropical dry evergreen forests (TDEFs) still occur.

Twelve landscapes consisting of forest fragments or scrubs and the surrounding landscape structure in radii of 1 and 5 km were studied. In this preliminary GIS-based study, satellite imagery (LISS 111) in four bands with a resolution of 30 m from Bhuvan, NRSA, India, for an total area of 70 km x 47 km was used to perform supervised classification based on Mahalanobis distance, using ERDAS 2014. The classified image with > 20 classes was digitalized and spatial geometry analysed using ARC-GIS 10.2.

We establish that there is natural regeneration of forests observable at mesoscale and landscape scale, with more scrubs being formed nearer to forests within the 1km radii (~4 km²) than further in the 5 km radii (~80 km²). The presentation will discuss the pattern and extent of scrub formation, and describe landscape heterogeneity representing different land-uses found in this region, described in terms of % of forest, % agricultural land, % constructed land, % scrub, % orchards, % plantations, and % tank-bunds (supporting linear tree cover that are maintained traditionally).

The role of these secondary forests in landscape scale conservation of fragmented forests needs to be emphasised.

P13 - Comparative analysis of bird habitat structures in different land utilization systems in the coffee region of Colombia

Kira Urban[1,2,3]

[1]Kira Urban, Göttingen, DE, kira.urban@stud.uni-goettingen.de
[2]Juan Carlos Camargo García, Pereira, CO, kira.urban@stud.uni-goettingen.de
[3]Christoph Kleinn, Göttingen, DE, kira.urban@stud.uni-goettingen.de

The intensive land use and the land cover change in Colombia lead to negative ecological consequences like forest fragmentation, loss of biodiversity and degradation of soil. To counteract these consequences agroforestry systems should present a possible solution. We hypothesized that a higher biodiversity results from a more structured landscape and that agroforestry systems could compensate the effects of fragmentation and intensive land use. This study uses abundance data of local avifauna at four different utilization systems in the coffee region of Colombia to evaluate the effects of various land uses. Methods like the rang abundance and rarefaction curves were used in this process to quantify the diversity of birds. Furthermore, the forest fragmentation due to land use was analyzed with several landscape metrics. With the combination of both mentioned datasets, species distribution models (SDM) were established. On the one hand, with the help of the SDM, the possibilities of the bird distribution should be shown. On the other hand, the birds' reaction to the influence of fragmentation and the different land utilization systems (especially agroforestry systems) should be derived. As part of the ongoing study a contribution to the recommendation of land use, as well as to the protection and promotion of biodiversity, should be served. Preliminary results seem to approve that the parameter of land use plays a sensitive role for the distribution of birds, but a more thorough research needs to be carried out to consolidate the outcomes.

END OF SESSION 48

Session 50 - Free Session

O1 - Intercontinental field survey disentangles the abiotic and biotic drivers of a plant invasion

Oliver Bossdorf[1], Robert Colautti[1], the Global Garlic Mustard Field Survey consortium[1]

[1]1University of Tübingen, Plant Evolutionary Ecology, Tübingen, DE

Many different hypotheses attempt to explain the success of plant invasions. Some invoke abiotic factors such as climate, others biotic factors such as enemy release. In reality, however, plant invasions are likely driven by multiple, partly confounded factors, and only large-scale studies are able to disentangle their relative importances. Here, we present the results of the Global Garlic Mustard Field Survey (GGMFS), a uniquely large 'coordinated distributed field survey' of the invasive plant *Alliaria petiolata*. Over several years, many different contributors surveyed 172 natural populations in the native European range and 223 populations in the invasive North American range. We find that Introduced populations are significantly larger and denser, with more expansive demographies, resulting in 14 megapopulations of 1,000,000+ individuals. These intercontinental differences were associated primarily with differences in climate and a lower incidence of fungal infection. Our project demonstrates the value of large collaborations in invasion biology.

P1 - Pollinator spill-over effects and potential indirect interactions between mango fields and the surrounding natural vegetation

Lavhelesani Simba[1,2], Stefan Foord[1], Elisa Thébault[3], Frank Van Veen[4], Colleen Seymour[2]

[1]Department of Zoology, University of Venda, Thohoyandou, ZA
[2]South African National Biodiversity, Cape Town, ZA
[3]Institute of Ecology and Environmental Sciences - Paris, UMR 7618 (UPMC, CNRS, IRD, INRA, UPEC, Paris Diderot), Université Pierre et Marie Curie, Paris, FR
[4]Centre for Ecology and Conservation, College of Life and Environmental Sciences, University of Exeter, Penryn Campus, Cornwall, UK

Much of the focus on crop pollination has been on the spillover of flower visitors from natural vegetation into croplands, few studies have considered whether the patterns of spillover are mirrored in the two habitats. Yet changes in seed set of entomophilous plants in natural vegetation owing to change in pollinator communities can have consequences for biodiversity conservation and maintenance of plant diversity necessary for healthy pollinator communities.

We investigated the effect of proximity to natural vegetation and mango (Mangifera indica) fields on flower visitors in mango and natural vegetation, respectively, before, during and after mango flowering. We also identified plant species which share flower visitors with mango to evaluate indirect effects between plants, and assessed whether flower abundance predicted plant species importance for flower visitors. Finally, we assessed whether introduction of managed honeybee hives into

orchards was associated with honeybee visitation to plants within nearby natural vegetation.

Flower visitation was greater in mango field than in natural vegetation during and after mango flowering but showed the opposite trend before mango flowering. In mango orchards, there were clear effects of distance on flower visitor abundance and richness, which declined by 59% and 75%, respectively, at 200 m from the natural vegetation. Distance had no effect on flower visitor richness or abundance in natural vegetation. Honey bee abundance in natural vegetation did not increase significantly in natural vegetation when honeybee hives were introduced to mango orchards.

Weeds in mango fields were important for mango flower visitors during mango flowering but a number of native species within natural vegetation supported mango flower visitors when mango was not flowering. Although plant species within the natural vegetation were important for the continued survival of mango pollinators when mango was not flowering (temporal spillover), we found no marked effects of spatial spillover during mango flowering. We found that mango flowers favoured different taxonomic groups of insects (e.g. flies and bees over beetles and ants) and so the presence of mass flowering crops may have long term implications for insect communities selecting for certain groups at the cost of others.

P2 - Biodiversity loss and ecosystem functioning: trophic network approach

Oksana Buzhdygan[1], Jana Petermann[1,2]

[1]Freie Universität Berlin, Berlin, DE, oksana.buzh@gmail.com
[2]University of Salzburg, Salzburg, AU

Analyses of experimental ecosystem studies rarely use a whole-system approach to address biodiversity–ecosystem functioning relationships. However, applying quantitative system modelling to empirical data is crucial if we are to fully understand these complex ecosystem processes. With the current study we integrate the quantitative modelling techniques of Network Analysis with empirical large-scale data of the Jena Experiment, a grassland biodiversity experiment in Germany. We constructed models of biomass-based quantitative trophic networks for the 80 experimental plots varying in plant species and functional diversity. Our models synthesize the empirically assessed parameters of above- and below-ground living and non-living compartments synthesizing multiple data sets as well as literature-based data. We analyzed the effect of *plant species richness*, *plant functional group richness,* and *presence/absence of four plant functional groups* on the following trophic ecosystem functions: *total gross production* (sum of outflows from the system), *total throughflow* (sum of flows through all compartments), *cycling index* (fraction of total flow that cycles) and *indirect effects index* (amount of flow that occurs over indirect versus direct connections). Our results show that *plant species richness* and *legume presence* significantly increase*system gross production* and that *total system throughflow* is similarly positively affected by *plant species richness*. *Cycling* is enhanced by the presence of legumes, while the *indirect effects index* increases with increasing *species richness*. These results demonstrate that plant diversity has whole-system-level effects on the ecosystem and its functions. For example, the effects of *plant species richness* on *total system throughflow* and *system gross production* show that plant diversity loss may reduce ecosystem activity. The positive effects of *plant species richness* on *indirect flows* may indicate stabilizing effectsof plant diversity on the ecosystem by making it more resistant to rapid changes by environmental perturbations.

P3 - Regeneration ecology of anemochorous tree species of the Cerrado in the Mbaracayú Nature Forest Reserve (MNFR), Paraguay

Giovanna da Ponte[1], Franka Huth[1], Sven Wagner[1]

[1]Institute of Silviculture and Forest Protection, Dresden University of Technology, Tharandt, DE

Seed dispersal and the efficiency of dispersal, especially in relation to distance, are key ecological aspects of plant population dynamics and niche partitioning among species.

This study was conducted in the Cerrado biome, part of the grand Central Brazilian plateau which extends to eastern Bolivia and northeastern Paraguay. It represents one of the 25 global biodiversity "hotspots". Endemism among the Cerrado higher plants is high, with an estimated 4,400 species, representing 1.5% of the world's total vascular plant species. The Cerrado is currently one of the most threatened biomes of South America due to the rapid expansion of agriculture. It comprises xeromorphic vegetation ranging from pure grasslands (open cerrado grassland) to savanna vegetation (e.g. scrub cerrado) and dense forest formations (cerradão).

Although the Cerrado has been identified as a biodiversity hotspot of worldwide importance, knowledge of the regeneration ecology of tree species is extremely limited.

Therefore in the following study seed dispersal ecology, the development of germinants under a fire regime and the spatial pattern of established seedlings in relation to ground cover competition is under investigation. The selected tree species, *Aspidosperma tomentosum* Mart., *Qualea grandiflora* Mart. and *Vochysia tucanorum,* are typical of the Cerrado biome in Mbaracayu Nature Forest Reserve. These tree species are characterised by an anemochorous seed dispersal process.

Preliminary results on seed dispersal for the tree species *Q. grandiflora* showed that mean dispersal distance (MDD) was about 38.8 m, and prevailing seed dispersal was anisotropic as a result of the prevailing wind direction during the abscission process. For the species *A. tomentosum,* seedling density was 0.21/m^2. For example the Spearman coefficient showed that the herbaceous cover was weakly correlated with the seedlings cover of species *A. tomentosum* (r = 0.33 and *p = 0.018*).

P4 - Pheromones and Other Semiochemicals for Sustainable Control of Lepidopterous Pests in Olive Farms in Egypt

Esmat M. Hegazi[1], Fredrik Schlyter[2], Wedad Khafagic[3], Maria Konstantopouloud[4], E. Agamy[5]

[1]Alexandria University, Alexandria, EG, eshegazi@hotmail.com
[2]Swedish University of Agriculture Sciences, Alnarp, SE
[3]Plant Protection Research Institute, Alexandria, EG
[4]Chemical Ecology and Natural Products Laboratory, NCSR "Demokritos",, Attikis, GR
[5]Faculty of Agriculture, Cairo of University, Kairo, EG

Prays oleae Bern, the olive moth (OM) , Palpita unionalis Hub., the jasmine moth (JM) and the leopard moth, Zeuzera pyrina L. (ZP) are the most important lepidopterous pests in olive orchards in Egypt, They cause direct yield loss by lowering tree growth, fruit set and fruit/oil quality. The sex pheromones of OM [(Z)-7-tetradecenal)] , JM E-11-hexadecenyl acetate and E-11-hexadecenal, and ZP (E,Z)-2,13-octadecenyl acetate were used for monitoring (all) , mating disruption (MD) (all), and mass trapping (ZP). Inclusion of photostablizers into the pheromone-clay complex of OM and JM improved substantially the release rate and maintained adequate level of pheromone. Fruit yield from trees where sex pheromone had been applied increased significantly compared to control ones . Application of MD in ZP plots over two consecutive years progressively reduced the number of active galleries/tree in the third year where no sex pheromone was applied. Mating disruption shows promising for suppressing ZP infestation in olives. The combination of light and sex pheromone was optimally attractive to ZP moths. Yield from trees in mass-trapping fields was significantly increased in comparison to control trees. Also,the study showed that susceptible varieties like Toffahi growing together in a plot with resistant cultivars (e.g. Shamy) tended to have lower attack densities, showing Associational Resistance (AR) at work. Development (survival, growth) of artificially infested larvae (no-choice test) within shoots took place successfully only in same varieties (e.g. Toffahi and Sennara), showing strict sense resistance to feeding. Contrary to expectations, surface wash and volatile collections in situ, analysed by GC and GC-MS, both showed that in terms of major peaks of released volatiles, the more resistant variety showed fewer and smaller peaks. We believe that cultivars with less insect infestation are resistant due to allelochemics affecting pre- or post-landing host selection or possibly habitat selection.

P5 - The maintenance of hybrids by parasitism in the freshwater snail Melanopsis

Yonathan Guttel[2], Frida Ben-Ami[1]

[1]Department of Zoology, George S. Wise Faculty of Life Sciences, Tel Aviv University, Tel-Aviv, IL
[2]Department of Life Sciences, Ben-Gurion University of the Negev, Be'er-Sheva, IL, yesguttel@gmail.com

Hybrids have been labeled evolutionary dead-ends due to their lower fertility and viability. However, there is growing evidence that interspecific hybridization (crossing between different species) plays a constructive role in animal evolution, which can create variability. We investigated whether parasite-mediated selection contributes to the maintenance of hybrids in 74 natural populations of the freshwater snail *Melanopsis*. We also examined in the laboratory whether resistance to parasites is traded-off with tolerance to low and high salinity levels and temperatures. We found that infection prevalence in *Melanopsis* hybrids was lower than in all parental taxa. Although infection was less prevalent in males than in females, and in deeper niches than in shallow ones, these differences were consistent across all species including hybrids. The differences in infection prevalence could not be explained by soil type, snail density and the geographical distribution of the sampling sites. Interestingly, infected hybrids did not show signs of gigantism, whereas all parental taxa did. Furthermore, in most cases hybrids coped with extreme temperature and salinity levels as good as or even better than their parental taxa. Taken together, our results suggest that parasite-mediated selection coupled with tolerance to environmental conditions contribute to the maintenance of *Melanopsis* hybrids. Our results also suggest that hybridization may be an adaptive host strategy to resist gigantism.

P6 - Effect of temperature on in vitro conidial germination in isolates of the nematode-trapping fungus Arthrobotrys

Cafer Eken[1], Nurdan Alkan[1], Mehmet Ali Söğüt[2], Fatma Gül Göze[2], Dudu Demir[1]

[1]Suleyman Demirel University Faculty of Agriculture Department of Agricultural Biotechnology, Isparta, TR, cafereken@sdu.edu.tr
[2]Suleyman Demirel University Faculty of Agriculture Department of Plant Protection, Isparta, TR

Nematophagous fungi have been the subject of research over several decades in fundamental studies of their ecology, distribution and systematics, and as potential biological control agents of plant parasitic nematodes. Nematophagous fungi can be divided into three major groups: the nematode-trapping fungi, the endoparasitic fungi and the egg- and cyst-parasitic fungi. The nematode-trapping fungi develop hyphal structures, such as nets, knobs, branches or rings to capture nematodes by adhesion or by mechanical means and they have been found in all regions of world. The genus *Arthrobotrys* belongs to the group of nematode-trappings fungi. These

fungi are relatively easy to culture on artificial media and numerous isolates are currently maintained in various laboratories worldwide.

This study, which aims at selecting strains with broad temperature range, examines the effect of temperature on conidial germination of strains of nematode-trapping fungus *Arthrobotrys*.

All isolates (CEA-1, CEA-2, CEA-3, CEA-4 and CEA-5) were obtained from alfalfa fields in Isparta province (Turkey) and were maintained on corn meal agar (CMA) in Petri dishes at 25 °C and transferred to fresh medium in every month. For sporulation, the fungus of 4-mm plugs was picked from periphery of stock culture and placed in the center of CMAY medium (CMA + 1% yeast extract). Conidial germination was tested at seven test temperatures: 10, 15, 20, 25, 30, 35 and 40 °C. An aqueous conidial suspension (100 µl containing 10^5 conidia) was spread on a slide coated with a thin film of potato dextrose agar (PDA) and CMA medium. The inoculated slides were kept in Petri dishes lined with blotting paper moistened with sterile water. The count of germinated conidia was taken at 24 h and 48 h after inoculation. Conidia were considered as germinated when the germination peg was at least twice the diameter of the conidium.

All the isolates showed more than 90% germination after 24 h at 20 and 25 °C. At 35 °C, only isolate CEA-5 showed more than 94% germination; others showed low germination (4-16% after 24 h. There is no germination at 40°C all *Arthrobotrys* isolates.

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P7 - Circadian asynchrony can enhance functional redundancy in tropical ant communities

Florian Menzel[1], Mickal Houadria[1]

[1]Johannes Gutenberg University, Mainz, DE, menzelf@uni-mainz.de

The diversity-stability relationship has been under intense scrutiny for the past decades, and temporal asynchrony is recognized as an important aspect of ecosystem stability. In contrast to relatively well-studied inter-annual and seasonal asynchrony, few studies investigate the role of circadian cycles for ecosystem stability. Here, we studied multifunctional redundancy of diurnal and nocturnal ant communities in four tropical rainforest sites. We analyzed how it was influenced by species richness, functional performance, and circadian asynchrony. In two neotropical sites, species richness and functional redundancy were lower at night. In contrast, these parameters did not differ in the two paleotropical sites we studied. Circadian asynchrony between species was pronounced in the neotropical sites, and increased circadian functional redundancy. In general, species richness positively af-

fected functional redundancy, but the effect size depended on the temporal and spatial breadth of the species with highest functional performance. Our analysis shows that high levels of trophic performance were only reached through the presence of such high-performing species, but not by even contributions of multiple, less efficient species. Thus, these species can increase current functional performance, but reduce overall functional redundancy.Our study highlights that diurnal and nocturnal ecosystem properties of the very same habitat can markedly differ in terms of species richness and functional redundancy. Consequently, like the importance to study multiple ecosystem functions, we need to study multiple time periods of the circadian cycle in order to fully understand the diversity-stability-relationship in an ecosystem and evaluate functional redundancy in different habitats.

END OF SESSION 50

LIST OF AUTHORS

LIST OF AUTHORS

Family name	First name	Organisation	Country	Email
Adler Yanez	Marcia A.	Georg-August-Universität Göttingen	DE	marcia_adler@hotmail.com
Agamy	Essam	Cairo univ	EG	essamagamy@yahoo.com
Ahnlund Ulvcrona	Kristina	Swedish University of Agricultural Sciences	SE	kristina.ulvcrona@slu.se
Akasbi	Zakia	University of Hamburg	DE	zakia.akasbi@uni-hamburg.de
Albrecht	Matthias	Agroscope	CH	matthias.albrecht@agroscope.admin.ch
Albrecht	Jörg	Polish Academy of Sciences	PL	albrechtjoerg@icloud.com
Alizadeh	Kamaleddin	Department of palynology and climate dynamics	DE	kamal.alizadeh@biologie.uni-goettingen.de
Allen	Kara	Soil Science of Tropical and Subtropical Ecosystems, Georg-August University Goettingen	DE	kara.allen@forst.uni-goettingen.de
Altermatt	Florian	Eawag/University of Zurich	CH	florian.altermatt@eawag.ch
Ammer	Christian	Göttingen University	DE	christian.ammer@forst.uni-goettingen.de
Andriessen	Nils	Driesen+Kern GmbH	DE	andriessen@driesen-kern.de
Ansell	Dean	Australian National University	AU	dean.ansell@anu.edu.au
Arbieu	Ugo	BiK-F Frankfurt	DE	ugo.arbieu@senckenberg.de
Astor	Tina	SLU Uppsala	SE	Tina.Astor@slu.se
Åström	Helena	University of Helsinki	FI	helena.astrom@helsinki.fi
Awad	Abdallah	Forest Botany and Plant Physiology Department, Büsgen institute	DE	aawad@gwdge.de
Bachofen	Christoph	ETH Zürich / WSL	CH	christoph.bachofen@wsl.ch
Backmann	Pia	iDiv - German Centre for Integrated Biodiversity research	DE	pia.backmann@ufz.de
Badami	Agrin	University of Teh-	IR	agrbadami@gmail.com

		ran		
Bader	Maaike	Philipps-University of Marburg	DE	maaike.bader@uni-marburg.de
Bähner	Kevin	Plant Ecology - University of Kaiserslautern	DE	baehner@rhrk.uni-kl.de
Baier	Fabian	University of Natural Resources and Life Sciences, Vienna	AT	FabianBaier89@gmail.com
Bajrami	Ani	University of Tirana	AL	ani.bajrami@fshn.edu.al
Balkenhol	Niko	Georg-August-Universität Göttingen	DE	nbalken@gwdg.de
Barnes	Andrew	University of Goettingen	DE	abarnes@gwdg.de
Bartomeus	Ignasi	EBD-CSIC	ES	nacho.bartomeus@gmail.com
Bässler	Claus	Nationalpark Bayerischer Wald	DE	claus.baessler@npv-bw.bayern.de
Batary	Peter	Georg-August-University, Agroecology	DE	pbatary@gmail.com
Baulechner	Dennis	department of animal ecology, JLU Giessen	DE	dennis.baulechner@allzool.bio.uni-giessen.de
Baur	Bruno	NLU, Universität Basel	CH	bruno.baur@unibas.ch
Bayandonoi	Gantulga	Georg-August University Goettingen	DE	B.Gantulga_mos@yahoo.com
Becker	Jeremias	Dept. System Ecotoxicology - UFZ	DE	jeremias.becker@ufz.de
Becks	Lutz	Max Planck Institute for Evolutionary Biology	DE	lbecks@evolbio.mpg.de
Behling	Hermann	University of Göttingen	DE	hbehlin@gwdg.de
Behringer	David	University of Marburg	DE	david.behringer@uni-marburg.de
Bekő	László	Károly Róbert College	HU	ifj.beko.laszlo@gmail.com
Benadi	Gita	University of Freiburg	DE	gita.benadi@biom.uni-freiburg.de
Berg	Matty	VU University / Department of Ecological Science	NL	m.p.berg@vu.nl
Berger	Uta	TU Dresden	DE	uta.berger@tu-dresden.de
Beyre	Friderike	Swedish University of Agricultural Sciences (SLU)	SE	friderike.beyer@slu.se
Beyschlag	Joachim	Universität Olden-	DE	j.beyschlag@uni-oldenburg.de

		burg		
Bialozyt	Ronald	Northwest German Forest Research Station	DE	ronald.bialozyt@nw-fva.de
Bieri	Mari	iDiv (German Centre for Integrative Biodiversity Research)	DE	mari.bieri@idiv.de
Birkhofer	Klaus	Lund University	SE	Klaus.Birkhofer@biol.lu.se
Bischofberger	Jenny	ISOE-Institute for Social-Ecological Research	DE	bischofberger@isoe.de
Blankenagel	Sonja	Technische Universität München, Ökophysiologie der Pflanzen	DE	sonja-blankenagel@arcor.de
Blaum	Niels	University of Potsdam	DE	blaum@uni-potsdam.de
Blüthgen	Nico	Fachbereich Biologie / TU Darmstadt	DE	bluethgen@bio.tu-darmstadt.de
Boch	Steffen	University of Bern/ Institute of Plant Sciences	CH	steffen.boch@ips.unibe.ch
Bögelein	Rebekka	University of Trier, Geobotany	DE	boegelein@uni-trier.de
Bohle	Victoria	Georg-August-University Göttingen	DE	v.bohle@stud.uni-goettingen.de
Boller	Jörn	Universität Bonn, INRES - Tierökologie	DE	joernboller@aol.com
Boltersdorf	Stefanie	University Bielefeld/Faculty Biology	DE	Stefanie.boltersdorf@uni-bielefeld.de
Bonn	Aletta	UFZ / iDiv	DE	aletta.bonn@idiv.de
Borre	Maria	Deutsche Forschungsgemeinschaft	DE	Maria.Borre@dfg.de
Bosem Baillod	Aliette	Agroecology, Georg-August University	DE	aliette.baillod@agr.uni-goettingen.de
Bossdorf	Oliver	University of Tübingen	DE	oliver.bossdorf@uni-tuebingen.de
Bowler	Diana	Senckenberg BiK-F	DE	diana.bowler@senckenberg.de
Bracis	Chloe	Senckenberg & Goethe Univ.	DE	cbracis@senckenberg.de
Brändle	Martin	Universität Marburg	DE	braendle@staff.uni-marburg.de
Braschler	Brigitte	University of Basel	CH	brigitte.braschler@unibas.ch
Bredemeier	Michael	Univ. Göttingen	DE	mbredem@gwdg.de
Bremerich	Vanessa	IGB	DE	bremerich@igb-berlin.de
Brinkmann	Nadine	ETH Zürich	CH	nadine.brinkmann@usys.ethz.ch

Bruelheide	Helge	Halle Univ. / Institute of Biology / Geobotany	DE	helge.bruelheide@botanik.uni-halle.de
Bu	Wen-Sheng	Institute of Botany,Chinese Academy of Sciences	CN	bws2007@163.com
Bucher	Roman	Universität Koblenz-Landau	DE	bucher@uni-landau.de
Buchmann	Carsten	University of Hohenheim	DE	carsten.buchmann@uni-hohenheim.de
Bursche	Vanessa	Institut für Umweltforschung, RWTH Aachen University	DE	vanessa.bursche@bio5.rwth-aachen.de
Busch	Verena	Institut für Landschaftsökologie Münster	DE	buschv@uni-muenster.de
Buse	Jörn	University Koblenz-Landau	DE	busej@uni-landau.de
Buzhdygan	Oksana	Freie Universität Berlin	DE	oksana.buzh@gmail.com
Byun	Jeagyun	RWTH Aachen University	DE	jaegyunb@gmail.com
Calabrese	Justin	Smithsonian Conservation Biology Institute	US	CalabreseJ@si.edu
Caperta	Ana D.	Instituto Superior de Agronomia, LEAF	PT	anadelaunay@isa.ulisboa.pt
Carstens	Frederic	Biodiversity, Evolution and Ecology, Biocenter Klein Flottbek,	DE	F.Carstens@gmx.net
Carus	Jana	University of Potsdam	DE	jana.carus@uni-potsdam.de
Castro-Izaguirre	Nadia	University of Zurich	CH	nadia.castro@ieu.uzh.ch
Cesarz	Simone	iDiv - German Centre for Integrative Biodiversity Research	DE	simone.cesarz@idiv.de
Chordekar	Sarah	University of Bath	UK	sarah.rsounds@gmail.com
CHOW-DHURY	ASIF MOINUR	University of Bremen, FB 02, UFT – Ecology,	DE	asifmoinur@uni-bremen.de
Clough	Yann	CEC Lund University	SE	yann.clough@cec.lu.se
Cuervo Alarcon	Laura Carolina	Forest Genetics and Forest Tree Breeding	DE	lcuervo@forst.uni-goettingen.de
Cumming	Graeme	James Cook University & University of Cape Town	AU	gscumming@gmail.com

Curdt	Constan-ze	University of Co-logne	DE	c.curdt@uni-koeln.de
Daguitan	Florence	Tebtebba Founda-tion	PH	flor@tebtebba.org
Danescu	Adrian	FVA-BW	DE	adrian.danescu@ymail.com
Darras	Kevin	University of Göt-tingen	DE	kdarras@gwdg.de
de Souza	Rubens	São Carlos Federal University (UFSCar)	BR	rubensgamaliel@hotmail.com
Deniau	Maud	UMR CNRS 6553 Ecobio/Univ. Rennes 1	FR	maud.deniau@univ-rennes1.fr
Denmead	Lisa	University of Göt-tingen	DE	lhdenmead@gmail.com
Diekötter	Tim	CAU-Institute for Natural Resource Conservation	DE	tdiekoetter@ecology.uni-kiel.de
Dieskau	Julia	Institut für Geobo-tanik MLU Halle	DE	julia.dieskau@yahoo.de
Dieterich	Burkart		DE	Burkart.Dieterich@web.de
Dise	Nancy	Centre for Ecology and Hydrology	UK	nadise@ceh.ac.uk
Dobeš	Christoph	Austrian Research Centre for Forests	AT	christoph.dobes@bfw.gv.at
Dolos	Klara	Karlsruhe Institute of Technology	DE	dolos@kit.edu
Dominik	Chris-tophe	Helmholtz Centre for Environmental Research - UFZ	DE	christophe.dominik@ufz.de
Dörler	Daniel	University of Natu-ral Resources and Life Sciences, Vien-na	AT	daniel.doerler@boku.ac.at
Dreber	Niels	North-West Univer-sity RSA	ZA	n.dreber@gmx.de
Drönner	Johannes	Philipps-Universität Marburg	DE	droenner@informatik.uni-marburg.de
Dudenhöff er	Jan-Hendrik	University of Frei-burg	DE	jan.dudenhoeffer@nature.uni-freiburg.de
Dymytrova	Lyudmyla	Swiss Federal Insti-tute for Forest, Snow and Land-scape Research WSL	CH	lyudmyla.dymytrova@wsl.ch
Ebeling	Anne	University Jena, Institute of Ecology	DE	anne.ebeling@uni-jena.de
Egorov	Eugen	Philipps Universität Marburg	DE	eugen.egorov@staff.uni-marburg.de
Ehrle	Antje	Friedrich Schiller University Jena	DE	antje.ehrle@uni-jena.de
Einzmann	Helena	CvO University	DE	helena.einzmann@uni-

		Oldenburg / IBU		oldenburg.de
Eken	Cafer	Suleyman Demirel University	TR	cafereken@sdu.edu.tr
Ekroos	Johan	Lund University	SE	johan.ekroos@cec.lu.se
Ellis Soto	Diego	Max Planck Institute for Ornithology, Vogelwarte Radolfzell	DE	Diego.Ellis-Soto@uni-konstanz.de
Entling	Martin	Institute for Environmental Sciences	DE	entling@uni-landau.de
Erfmeier	Alexandra	Institute for Ecosystem Research / Kiel University	DE	aerfmeier@ecology.uni-kiel.de
Esser	Daniel S.	University of Göttingen	DE	desser@uni-goettingen.de
Estravis Barcala	Maximiliano	INTA EEA, Genética Ecológica y Mejoramiento Forestal	AR	estravis.maximiliano@inta.gob.ar
Evans	Steven	University of Venda	ZA	stevenwe@vodamail.co.za
Everwand	Georg	Thünen Institute of Biodiversity	DE	georg.everwand@ti.bund.de
Ewald	Michael	Karlsruhe Institute of Technology	DE	michael.ewald@kit.edu
Fan	Yuanchao	Abteilung für Bioklimatologie der Universität Göttingen	DE	yfan1@gwdg.de
Fartmann	Thomas	University of Osnabrück, Ecology, Department of Biology/Chemistry	DE	Thomas.Fartmann@biologie.uni-osnabrueck.de
Farwig	Nina	University of Marburg	DE	farwig@biologie.uni-marburg.de
Feigs	Jannis Till	Universität Hamburg AG Biodiversität der Nutzpflanzen	DE	jtfeix@mail.de
Feilhauer	Hannes	FAU Erlangen-Nürnberg	DE	hannes.feilhauer@fau.de
Feldmann	Eike	Ökologie und Ökosystemforschung	DE	efeldma1@gwdg.de
Ferlian	Olga	iDiv Halle-Jena-Leipzig	DE	olga.ferlian@idiv.de
Fiedler	Sebastian	Freie Universität Berlin	DE	sebastian.fiedler@online.de
Finckh	Manfred	Biocentre Klein Flottbek, University of Hamburg	DE	manfred.finckh@uni-hamburg.de
Fischer	Joern	Leuphana University	DE	joern.fischer@uni.leuphana.de

Fischer	Christina	Restoration Ecology, TUM	DE	christina.fischer@tum.de
Fleischer	Dirk	Helmholtz-Zentrum für Ozeanforschung GEOMAR	DE	dfleischer@geomar.de
Foord	Stefan	University of Venda	ZA	stefan@foord.co
Francioli	Davide	Helmholtz Centre for Environmental Research - UFZ	DE	davide.francioli@ufz.de
Frank	Anke	UTas	AU	anke.frank@utas.edu.au
Frank	Thomas	Institute of Zoology, Department of Integrative Biology & Biodiversity Research, University of Natural Resources and Life Sciences Vienna	AT	thomas.frank@boku.ac.at
Freimoser	Florian	Agroscope	CH	florian.freimoser@agroscope.admin.ch
Friede	Martina	Universität Bielefeld	DE	friede@uni-bielefeld.de
Frieß	Nicolas	AG Brandl - Philipps-Universität Marburg	DE	Friessn@students.uni-marburg.de
Fritsch	Matthias	Ecosystem Modelling, University of Göttingen, Germany	DE	matthias.fritsch@forst.uni-goettingen.de
Fritz	Susanne	Senckenberg Biodiversity and Climate Research Centre (BiK-F) & Goethe University Frankfurt	DE	sfritz@senckenberg.de
Frömmcke	Benjamin	ecoTech Umwelt-Meßsysteme GmbH	DE	ecotech@ecotech-bonn.de
Fronhofer	Emanuel	Eawag / Univ. Zurich	CH	emanuel.fronhofer@eawag.ch
Fründ	Jochen	Integrative Biology, University of Guelph	CA	jfruend@uoguelph.ca
Gaikwad	Jitendra	Friedrich-Schiller-Universität Jena	DE	jitendra.gaikwad@uni-jena.de
Galiano Perez	Lucia	Swiss Federal Institute for Forest, Snow and Landscape Research WSL	CH	lucia.galiano@wsl.ch
Ganzhorn	Jörg	Universität Hamburg	DE	ganzhorn@uni-hamburg.de

García	Jaime	IRI THESys - Humboldt University Berlin	DE	jaime.garcia.marquez@gmail.com
Gattringer	Johannes	University Giessen	DE	johannes.gattringer@umwelt.uni-giessen.de
Gayer	Christoph	HfWU Nürtingen-Geislingen	DE	christoph.gayer@hfwu.de
Gebhardt	Timo	Georg August Universität Göttingen	DE	timo_gebhardt@gmx.de
Geedicke	Ina	Universität Hamburg	DE	ina.geedicke@gmail.com
Gemeinholzer	Birgit	University Giessen - Special Botany	DE	birgit.gemeinholzer@bot1.bio.uni-giessen.de
Gérard	Anne	Universität Göttingen	DE	agerard@forst.uni-goettingen.de
GERZABEK	Gabriel	UMR 1202 Biogeco	FR	gerzabek@pierroton.inra.fr
Getzin	Stephan	Dept. Ecol. Modelling, UFZ	DE	stephan.getzin@ufz.de
Glatthorn	Jonas	University of Göttingen - Plant Ecology and Ecosystem Research	DE	jglatth@gwdg.de
Goisser	Michael	Technische Universität München	DE	goisser@mytum.de
Gómez Díaz	Jorge Antonio	Georg-August-Universität Göttingen	DE	jgomezd@gwdg.de
Gonther	Annika	University of Marburg	DE	annika_gonther@web.de
Gonzalez Mace	Odette	University of göttingen	DE	ogonzal@gwdg.de
González-Varo	Juan P.	Estación Biológica de Doñana (EBD-CSIC)	ES	juanpe@ebd.csic.es
Goßner	Martin	Technische Universität München	DE	martin.gossner@tum.de
Gottstein	Malika	Philipps-University Marburg	DE	malika.gottstein@gmx.de
Grace	Miriam	Jacobs University Bremen	DE	m.grace@jacobs-university.de
Graefe	Sophie	Universität Göttingen	DE	sgraefe@gwdg.de
Graham	Catherine	Stony Brook Univesrity	US	catherine.graham@stonybrook.edu
Grams	Thorsten	TU München - Ecophysiology	DE	grams@tum.de
Gras	Pierre	G.-A.University Göttingen, Agroecology	DE	pgras@gwdg.de
Grass	Ingo	Georg-August-Universität Göttin-	DE	ingo.grass@agr.uni-goettingen.de

		gen		
Grefen	Claudio	University of Mar-burg	DE	grefen@students.uni-marburg.de
Groeneveld	Jürgen	Helmholtz - UFZ - Leipzig	DE	juergen.groeneveld@ufz.de
Grün	Melanie	University of Mar-burg	DE	Gruenme@students.uni-marburg.de
Grüning	Maren	Georg-August Universität	DE	mgrueni1@gwdg.de
Gu	Fang	Albrecht-von-Haller Institute for Plant Sciences	DE	Fang.Gu@biologie.uni-goettingen.de
Guarinello de Oliveira Portes	Maria Carolina	Albrecht-von-Haller Institute for Plant Sciences	DE	mguarin@uni-goettingen.de
Guerreiro	Marco	Ruhr-Universität Bochum	DE	Marco.Guerreiro@rub.de
Günther	Anke	Universität Rostock	DE	anke.guenther@uni-rostock.de
Guo	Xiaohui	FREIE UNIVERSITÄT BERLIN	DE	xhguo86@hotmail.com
Guo	Tong	Freie Universität Berlin	DE	guoy_6857@163.com
Guschal	Maike	Senckenberg Re-search Institution, Museum of Zoology Dresden	DE	maike.guschal@senckenberg.de
Guttel	Yonathan	Ben-Gurion Univer-sity of the Negev	IL	yesguttel@gmail.com
Habel	Jan Chris-tina	Dr.	DE	Janchristianhabel@gmx.de
Hagemann	Ulrike	ZALF e.V.	DE	ulrike.hagemann@zalf.de
Ha-genbucher	Steffen	Agroscope, Insti-tute for Sustainabil-ity Sciences	CH	stef-fen.hagenbucher@agroscope.admin.ch
Hagge	Jonas	Philipps Universität Marburg - Tierökologie	DE	jonashagge@yahoo.de
Hahn	Claudia	University of Basel	CH	claudia.hahn@unibas.ch
Haider	Sylvia	Geobotany, MLU Halle-Wittenberg	DE	sylvia.haider@botanik.uni-halle.de
Hanke	Jana Melanie	HAWK - Göttingen	DE	jana.hanke@gmx.de
Hanspach	Jan	Leuphana Universi-ty Lüneburg	DE	hanspach@leuphana.de
Hanß	Sebastian	Department of Ecosystem Model-ling, Georg-August-University of Göt-tingen	DE	sebastian@hanss.info
Hapsari	Kartika Anggi	Albrecht-von-Haller Inst., University of	DE	Kartika.Hapsari@biologie.uni-goettingen.de

		Goettingen		
Hartig	Florian	Uni Freiburg	DE	florian.hartig@biom.uni-freiburg.de
Hartmann	Matthias	Charles University in Prague	CZ	m.hartmann301187@gmail.com
Hartmann	Henrik	Max-Planck Institute for Biogeochemistry	DE	hhart@bgc-jena.mpg.de
Haß	Annika	G.-A.-University Göttingen	DE	ahass@uni-goettingen.de
Hassler	Evelyn	University of Goettingen	DE	epreuss@gwdg.de
Heer	Katrin	University of Marburg	DE	katrin.heer@uni-marburg.de
Hegazi	Esmat M.	Alexandria University,Egypt,Faculty of Agriculture	EG	eshegazi@hotmail.com
Heidemann	Kerstin	Georg August University Göttingen	DE	kheidem@gwdg.de
Heidrich	Lea	Philipps Universität Marburg	DE	lea.heidrich@gmx.de
Heigl	Florian	BOKU, Vienna	AT	florian.heigl@boku.ac.at
Heilmeier	Hermann	TU Bergakademie Freiberg	DE	heilmei@ioez.tu-freiberg.de
Heim	Rene	Universität Hamburg	DE	rene.h.j.heim@googlemail.com
Heimsch	Florian	Göttingen University, Bioclimatology Departement	DE	florian.heimsch@forst.uni-goettingen.de
Heine	Peggy	RWTH Aachen University	DE	peggyheine@bio5.rwth-aachen.de
Heinonen	Johannes	University of Göttingen	DE	jheinon@gwdg.de
Henselek	Yuki	University of Freiburg	DE	yuki.henselek@ere.uni-freiburg.de
Herbertsson	Lina	CEC, Lund University	SE	lina.herbertsson@cec.lu.se
Herrmann	John	Christian-Albrechts-Universität zu Kiel	DE	eco.herrmann@gmail.com
Hess	Bastian	University of Göttingen	DE	bastian.hess@forst.uni-goettingen.de
Hoch	Guenter	University of Basel	CH	guenter.hoch@unibas.ch
Hock	Maria	Kiel University	DE	mhock@ecology.uni-kiel.de
Hoda	Ali	Albrecht-von-Haller Institut for Plant Science	DE	bmhoda66@hotmail.com
Hof	Christian	Senckenberg - BiK-F	DE	christian.hof@senckenberg.de
Hoffmann	Uta Sophie	CAU Kiel Landscape Ecology	DE	uhoffmann@ecology.uni-kiel.de
Hofmann	Karina	Martin-Luther-Universität Halle-	DE	karina.hofmann@botanik.uni-halle.de

		Wittenberg		
Hohnwald	Stefan	Landscape Ecology, Institute of Geog-raphy, Georg-August University of Göttingen	DE	shohnwa@gwdg.de
Homeier	Jürgen	University of Göt-tingen	DE	jhomeie@gwdg.de
Hönig	Lydia	MLU Halle-Wittenberg	DE	lydia.hoenig@botanik.uni-halle.de
Hörandl	Elvira	University of Göt-tingen, Dept. Sys-tematics, Biodiver-sity and Evolution of Plants	DE	elvira.hoerandl@biologie.uni-goettingen.de
Horgan	Katie	IEU, University of Zürich	CH	katherine.horgan@ieu.uzh.ch
Hotes	Stefan	Philipps-University	DE	stefan.hotes@uni-marburg.de
Hövemeyer	Klaus	University of Göt-tingen	DE	khoevem@gwdg.de
Hüfner	Rebekka	CESR - Universität Kassel	DE	rebekka.huefner@usf.uni-kassel.de
Hülsmann	Lisa	Eidg. Forschung-sanstalt WSL	CH	lisa.huelsmann@wsl.ch
Husemann	Martin	Martin_Luther University Halle-Wittenberg	DE	martinhusemann@yahoo.de
Huth	Franka	Dresden University of Technology	DE	f.huth@freenet.de
Ibe	Karin	Leuphana Universi-ty Lüneburg	DE	karin.ibe@stud.leuphana.de
Ichinose	Tomohiro	Keio University	JP	tomohiro@sfc.keio.ac.jp
Iles	Alison	iDiv	DE	alison.iles@idiv.de
Inken	Dörfler	Technische Univer-sität München	DE	inkendoerfler@gmail.com
Irl	Severin	Biogeography, University of Bay-reuth	DE	severin.irl@uni-bayreuth.de
Ives	Chris	Leuphana Universi-tät	DE	christopher.d.ives@gmail.com
Jákli	Bálint	IAPN Göttingen	DE	jakli@iapn-goettingen.de
Jakoby	Oliver	Swiss Federal Re-search Institute WSL	CH	oliver.jakoby@wsl.ch
jang	hyonchol	university of goettingen	DE	hyoncholforest@gmail.com
Jansen	Florian	University of Greifswald	DE	jansen@uni-greifswald.de
Jeanneret	Philippe	Agroscope ISS	CH	philippe.jeanneret@agroscope.admin.ch
Jerrentrup	Sabrina	Thünen Institute of	DE	sabrina.jerrentrup@ti.bund.de

		Biodiversity		
Jochum	Malte	University of Goettingen	DE	mjochum@gwdg.de
John	Katharina	Department of Animal Ecology; Justus-Liebig-University Giessen	DE	Katharina.John@allzool.bio.uni-giessen.de
Johnson	Nancy	Northern Arizona University	US	Nancy.Johnson@nau.edu
Johnson	David	Australian National University	AU	david.johnson@anu.edu.au
Joschinski	Jens	University of Würz-burg	DE	Jens.Joschinski@uni-wuerzburg.de
Kahmen	Ansgar	University of Basel	CH	ansgar.kahmen@unibas.ch
Kaiser	Hartmut	Botanisches Institut der Christian-Albrechts-Universität zu Kiel	DE	hkaiser@bot.uni-kiel.de
Kaiser-Bunbury	Christo-pher	Ecological Net-works, TU Darm-stadt	DE	ckaiser-bunbury@bio.tu-darmstadt.de
Kalda	Rauno	University of Tartu	EE	kalda_r@ut.ee
Kalinkat	Gregor	ETH-Eawag	CH	gregor.kalinkat@eawag.ch
Kalwij	Jesse	Kiel University	DE	jessek@uj.ac.za
Kambach	Stephan	Helmholtz Centre for Environmental Research - UFZ	DE	stephan.kambach@ufz.de
Kamlun	Kamlisa Uni	Nature Conserva-tion and Landscape Planning, Faculty of Forest Sciences and Forest Ecology Goettingen Univer-sity	DE	unikamlun@gmail.com
Kattge	Jens	Max Planck Insti-tute for Biogeo-chemistry	DE	jkattge@bgc-jena.mpg.de
Kaur	Pawande ep	Friedrich-Schiller-Universität,Jena	DE	pawandeep.kaur@uni-jena.de
Kautzner	Antje	Helmholtz-Zentrum für Umwelt-forschung	DE	antje.kautzner@ufz.de
Kawo	Samuel Tuffa	universität Hohen-heim	DE	satukada@gmail.com
Kelemen-Finan	Julia	NÖ Na-turschutzakademie	AT	j.kelemenfinan@gmail.com
ken	william	27	US	aibaiw2825434@163.com
Khansari-toreh	Elmira	Department of Plant Ecology and Ecosystem Re-search, University	DE	ekhansa@gwdg.de

		of Göttingen		
Khorozyan	Igor	Georg-August University of Göttingen	DE	igor.khorozyan@biologie.uni-goettingen.de
Kienle	David	University of Bayreuth	DE	david.kienle@uni-bayreuth.de
Kim	cholhun	george august goettingen university	DE	forestmana@outlook.de
Kirchheimer	Bernhard	University of Vienna	AT	bernhard.kirchheimer@univie.ac.at
Klan	Friederike	Friedrich-Schiller-University Jena	DE	friederike.klan@uni-jena.de
Klatt	Simone	University Göttingen	DE	sklatt@uni-goettingen.de
Klaus	Felix	University of Göttingen	DE	felix.klaus@stud.uni-goettingen.de
Klaus	Valentin	Universität Münster	DE	v.klaus@uni-muenster.de
Klein	Alexandra-Maria	Universität Freiburg	DE	alexandra.klein@nature.uni-freiburg.de
Kleinspehn	Clemens	Universität Bern, IPS	CH	clemens.kleinspehn@ips.unibe.ch
Knohl	Alexander	University Göttingen	DE	aknohl@uni-goettingen.de
Koch	Marian	University of Rostock	DE	marian.koch@uni-rostock.de
Koch	Barbara	University Freiburg	DE	barbara.koch@felis.uni-freiburg.de
Köhler	Julia	Plant Ecology, Uni Goettingen	DE	julia.koehler@biologie.uni-goettingen.de
Koim	Nora	Eberswalde University for Sustainable Development	DE	nora.koim@hnee.de
Kolb	Annette	University of Bremen	DE	akolb@uni-bremen.de
Koller	Robert	IBG 2: Plant Sciences / Forschungszentrum Jülich GmbH	DE	r.koller@fz-juelich.de
Kolychalow	Olga	Bundesanstalt für Gewässerkunde	DE	Kolychalow@bafg.de
König	Christian	Biodiversity, Macroecology & Conservation Biogeography Group, University of Göttingen	DE	Christian.Koenig@forst.uni-goettingen.de
Konrad	Jessika	Leibniz-Center for Agricultural Landscape Research	DE	konrad@zalf.de
Konsens	Irit	HEBREW UNI.	IL	irit.konsens@mail.huji.ac.il

		JERUSALEM		
Koppen-steiner	Wiltrut	University of Natural Resources and Life Sciences Institute of Zoology	AT	wiltrut.k@gmx.at
Korn	Sandra	Institute of Forest Botany, TU Dresden	DE	korn@forst.tu-dresden.de
Körner	Christian	University of Basel, Institute of Botany	CH	ch.koerner@unibas.ch
Kotowska	Martyna	University of Göttingen	DE	mkotows@gwdg.de
Krahner	André	Universität Trier	DE	andre.krahner@gmail.com
Krämer	Roland	Helmholtz Centre for Environmental Research (UFZ)	DE	roland.kraemer@idiv.de
Krämer	Klara	RWTH Aachen University / Institute for Environmental Research (Biology V)	DE	klara.kraemer@rwth-aachen.de
Kreft	Holger	University of Göttingen	DE	hkreft@uni-goettingen.de
Krimmer	Elena	Universität Würzburg	DE	elena.krimmer@uni-wuerzburg.de
Krippes	Christian	Department of Animal Ecology Justus-Liebig University Giessen	DE	Christian.Krippes@bio.uni-giessen.de
Kubisch	Alexander	University of Hohenheim	DE	akubisch@posteo.de
Kupsch	Denis	Georg-August University Göttingen	DE	dkupsch@gwdg.de
Kurniawan	Syahrul	Soil science department, Faculty of Agriculture, University of Brawijaya	ID	kurniawan_syahrul@yahoo.com
Kurucz	Kornélia	unemployed	HU	kornelia.kurucz@gmail.com
Kurze	Susanne	Universität Potsdam	DE	lilium_brevis@web.de
Kütt	Laura	University of Tartu	EE	a61667@ut.ee
Lang	Petra	Universität Trier, FB VI - Geobotanik	DE	langp@uni-trier.de
Langen-berger	Gerhard	University of Hohenheim	DE	langenbe@uni-hohenheim.de
Lanzen	Jonathan	University of Würzburg Institute for Animal Ecology and Tropical Biology	DE	jonathan.lanzen@uni-wuerzburg.de
László	Zoltán	UBB Cluj-Napoca	RO	laszlozoltan@gmail.com

Latz	Ellen	iDiv Halle-Jena-Leipzig	DE	ellen.latz@idiv.de
Laug	Andreas	Universität Göttingen	DE	andreasjlaug@gmail.com
Lauströer	Verena	Hochschule Geisenheim	DE	verena.laustroeer@hs-gm.de
Lemken	Dominic	University Göttingen	DE	dominic.lemken@web.de
Lenhart	Katharina	JLU Gießen, Department of Plant Ecology	DE	katharina.lenhart@bot2.bio.uni-giessen.de
Lenzner	Bernd	University Vienna	AT	bernd_lenzner@gmx.de
Leonhardt	Sara	University of Würzburg	DE	sara.leonhardt@uni-wuerzburg.de
Leuschner	Christoph	University of Göttingen	DE	cleusch@gwdg.de
Leyer	Ilona	Geisenheim University	DE	ilona.leyer@hs-gm.de
Li	Yuanheng	Deutsches Zentrum für integrative Biodiversitätsforschung (iDiv) Halle-Jena-Leipzig	DE	yuanheng.li@idiv.de
Liang	Yu	Institute of Botany, CAS	CN	coolrain@ibcas.ac.cn
Liepelt	Sascha	University of Marburg	DE	liepelt@biologie.uni-marburg.de
Lindner	Steve	University of Bayreuth, Plant Ecology, BayCEER	DE	stevelindner@yahoo.de
Linstädter	Anja	University of Cologne, Botanical Institute, Range Ecology and Range Management Group	DE	anja.linstaedter@uni-koeln.de
Lintzel	Esther-Marie	University of Marburg	DE	Lintzel@students.uni-marburg.de
Liu	Xiaojuan	Institute of Botany, Chinese Academy of Sciences	CN	liuxiaojuan06@ibcas.ac.cn
Löbel	Swantje	SLU Uppsala/TU Braunschweig	DE	swantje.lobel@slu.se
Lososová	Zdeňka	Masaryk University	CZ	lososova@sci.muni.cz
Ludewig	Kristin	Institute of Landscape Ecology and Resource Management, Justus Liebig University Giessen	DE	kristin.ludewig@umwelt.uni-giessen.de
Lühken	Renke	Bernhard Nocht Institute for Tropi-	DE	luehken@bnitm.de

		cal Medicine		
Ma	Keping	Institute of Botany, Chinese Academy of Sciences	CN	kpma@ibcas.ac.cn
Maaroufi	Nadia	SLU, Umeå, Sweden	SE	nadia.maaroufi@slu.se
Maas	Bea	University of Göttingen	DE	beamaas@gmx.at
Macandog	Damasa	University of the Philippines Los Banos	PH	demi_macandog@yahoo.com
MacLaren	Chloe	CAWR Coventry University	UK	chloemaclaren@gmail.com
Mader	Viktoria	Justus-Liebig-Universität Giessen, Animal Ecology	DE	viktoria.l.mader@allzool.bio.uni-giessen.de
Magiera	Anja	JLU Giessen	DE	Anja.Magiera@agrar.uni-giessen.de
Malyshev	Andrey	University of Greifswald	DE	andrey.malyshev@uni-greifswald.de
Manning	Peter	BiK-F	DE	peter.manning@senckenberg.de
Mantilla-Contreras	Jasmin	University of Hildesheim, Institute for Biology and Chemistry, RG Ecology and Environmental Education	DE	mantilla@uni-hildesheim.de
Maraun	Melanie	Animal ecology, J.F. Blumenbach Institute of Zoology and Anthropology	DE	mpollie@gwdg.de
Martin	Ludmilla	University of Picardie Jules Verne	FR	ludmilla.martin@u-picardie.fr
Martín-López	Berta	Autonomous University of Madrid	ES	berta.martin@uam.es
May	Felix	iDiv / UFZ Leipzig	DE	felix.may@ufz.de
Meijide	Ana	Georg-August University Göttingen	DE	ameijid@gwdg.de
Mellard	Jarad	CNRS	FR	jarad.mellard@ecoex-moulis.cnrs.fr
Meller	Paulina	Universität Hamburg	DE	paulina.meller@gmx.de
Melliger	Ramona	Uni Basel - NLU	CH	Ramona.Melliger@unibas.ch
Menzel	Florian	University of Mainz	DE	menzelf@uni-mainz.de
Messier	Christian	University of Quebec in Montréal (UQAM)	CA	messier.christian@uqam.ca
Meyer	Peter	Nordwestdeutsche Forstliche Versuchsanstalt	DE	Peter.Meyer@nw-fva.de

Meyer	Sebastian T.	Technische Universität München	DE	sebastian.t.meyer@tum.de
Meyer	Carsten	University of Göttingen	DE	cmeyer2@uni-goettingen.de
Meyer	Katrin	University of Göttingen	DE	kmeyer5@gwdg.de
Mi	Xiang-cheng	Institute of Botany, Chinese Academy of Sciences	CN	mixiangcheng@gmail.com
Michaelis	Jana	University of Bremen	DE	jana.michaelis@uni-bremen.de
Möckel	Thomas	Universität Kassel	DE	thomas.moeckel.sci@gmail.com
Mölder	Andreas	Northwest German Forest Research Station	DE	andreas.moelder@nw-fva.de
Moreno-Gutierrez	Cristina	UNIVERSITY OF BASEL	CH	cristina.morenogutierrez@unibas.ch
Moretti	Marco	Swiss Federal Research Institute	CH	marco.moretti@wsl.ch
Mosena	Alexander	Universität Bielefeld	DE	alexander.mosena@uni-bielefeld.de
Moser	Barbara	Swiss Federal Institute for Forest, Snow and Landscape Research WSL	CH	barbara.moser@wsl.ch
Moyano	Fernando	Bioclimatology, Universitaet Goettingen	DE	fmoyano@uni-goettingen.de
Mudongo	Edwin	Range Ecology and Range Management Group Botanical Institute, University of Cologne	DE	edwin.mudongo810@gmail.com
Mueller	Thomas	Senckenberg & Goethe Univ.	DE	muellert@gmail.com
Müller	Jörg	TU München	DE	joerg.mueller@npv-bw.bayern.de
Müller	Hanno	ZMT Bremen	DE	hanno.mueller@zmt-bremen.de
Müller	Lilian-Lee	CvO University of Oldenburg	DE	lilian-lee.mueller@uni-oldenburg.de
Müller	Christina M.	Systematic Botany	DE	Christina.M.Mueller@bot1.bio.uni-giessen.de
Müller	Gregor	University of Konstanz	DE	muellersgreg@googlemail.com
Mumme	Steffen	Universität Göttingen	DE	steffen.mumme@gmx.net
Münch	Elise	University of Potsdam, Plant Ecology and Nature Conservation	DE	elise.muench@uni-potsdam.de

Mylenka	Myrosla-va	Vasyl Stefanyk Precarpathian National University	UA	mulenka.m@gmail.com
Naah	John-Baptist S. N.	University of Co-logne/Botanical Institute	DE	jeanlebaptist@yahoo.co.uk
Nagy	H. Beáta	MTA-DE Biodiversi-ty and Ecosystem Services Research Group	HU	nagy.beata@gmail.com
Nguyen	Quang Dung	Department of Foest Botany and Tree Physiology; Göttingen Universi-ty	DE	dung.nguyen-quang@forst.uni-goettingen.de
Nopper	Joachim	Universität Ham-burg	DE	Joachim.Nopper@uni-hamburg.de
Nuske	Robert	NW-FVA	DE	robert.nuske@nw-fva.de
Oberhuber	Walter	University of Inns-bruck, Institute of Botany	AT	walter.oberhuber@uibk.ac.at
Oldeland	Jens	University of Ham-burg	DE	jens.oldeland@uni-hamburg.de
Opfermann	Nicole	A-v-H-Inst. for Plant Sciences	DE	nopferm@gwdg.de
Opge-noorth	Lars	Department of Ecology, Animal Ecology, Philipps-Universität Mar-burg	DE	Opgenoorth@uni-marburg.de
Osen	Kristina	Philipps-University Marburg	DE	Osen@students.uni-marburg.de
Ott	David	University of Göt-tingen	DE	dott@gwdg.de
Owonibi	Michael	Institut für Informa-tik , Friedrich-Schiller-University	DE	michael.owonibi@uni-jena.de
Paal	Taavi	University of Tartu	EE	taavi.paal@ut.ee
Pachinger	Bärbel	BOKU, Vienna	AT	baerbel.pachinger@boku.ac.at
Pagel	Joern	Universität Hohen-heim	DE	jpagel@uni-hohenheim.de
Pei	Zhiqin	Helmholtz Centre for Environmental Research GmbH - UFZ	DE	zhiqin.pei@ufz.de
Pena	Rodica	University of Göt-tingen	DE	rpena@gwdg.de
Pennekam p	Frank	University of Zurich	CH	frank.pennekamp@ieu.uzh.ch
Pereira	Henrique	iDiv	DE	hpereira@idiv.de
Pérez	Cecilia	Instituto de	CL	cperez@bio.puc.cl

		Ecología y Biodiversidad		
Persoh	Derek	Ruhr-Universität Bochum	DE	derek.persoh@rub.de
Petchey	Owen	University of Zurich	CH	owen.petchey@ieu.uzh.ch
Pfaden-hauer	Jörg	Technische Univer-sität München	DE	pfadenha@wzw.tum.de
Pfaff	Claas-Thido	University of Leip-zig	DE	claas-thido.pfaff@uni-leipzig.de
Pfaffen-berger	Veronika	Universität Ham-burg/ Biodiversität der Nutzpflanzen	DE	Veronika-Pfaffenberger@hotmail.de
Pfeiffer	Simone	Georg-August-University Göttin-gen	DE	spfeiff@gwdg.de
Pfister	Sonja	University Landau AG Ecosystem analysis	DE	pfister@uni-landau.de
Piché	Raphaële	Centre for Forest Research (CEF), Université du Qué-bec à Montréal, Canada	CA	piche.raphaele@courrier.uqam.ca
Piepho	Maike	University of Ros-tock	DE	maike.piepho@uni-rostock.de
Pingel	Martin	Institut für Botanik, Hochschule Gei-senheim	DE	martin.pingel@hs-gm.de
Pinkert	Stefan	Philipps Universität Marburg	DE	StefanPinkert@posteo.de
Platen	Ralph	Leibniz-Center for Agricultural Land-scape Research	DE	platen@zalf.de
Plieninger	Tobias	University of Co-penhagen	DK	tobias.plieninger@ign.ku.dk
Pontarp	Mikael	University of Zurich	CH	mikael.pontarp@biol.lu.se
Potthoff	Martin	University of Göt-tingen	DE	mpottho@gwdg.de
Primack	Richard	Boston University	US	primack@bu.edu
Prinzing	Andreas	Univ Rennes 1	FX	andreas.prinzing@univ-rennes1.fr
Pufal	Gesine	University of Frei-burg	DE	Gesine.pufal@nature.uni-Freiburg.de
Purschke	Oliver	German Centre for Integrative Biodi-versity Research (iDiv) Halle-Jena-Leipzig	DE	oliver.purschke@idiv.de
Raderma-cher	Nico	Uni Göttingen, Tierökologie	DE	nraderm@gwdg.de
Rall	Björn	German Centre for Integrative Biodi-	DE	bjoern.rall@idiv.de

		versity Research (iDiv) Halle-Jena-Leipzig		
Ratzmann	Gregor	FU Berlin	DE	gregor.ratzmann@fu-berlin.de
Rau	Anna-Lena	Leuphana University of Lüneburg	DE	anna-lena.rau@leuphana.de
Rauner	Sebastian	Helmholtz Centre for Environmental Research - UFZ	DE	sebastian.rauner@ufz.de
Redelstein	Regine	Plantecology, Uni Göttingen	DE	regine.redelstein@biologie.uni-goettingen.de
Redlich	Sarah	University of Würzburg	DE	sarah.redlich@uni-wuerzburg.de
Reeg	Jette	Universität Potsdam	DE	jreeg@uni-potsdam.de
Reichert	Wolfgang	SNSB IT Center	DE	reichert@bsm.mwn.de
Reininghaus	Hannah	Universität Göttingen	DE	hreinin@gwdg.de
Remus-Emsermann	Mitja	Agroscope	CH	mitja.remus@agroscope.admin.ch
Renken	Dorothea	Philipps University Marburg	DE	renkend@students.uni-marburg.de
Revermann	Rasmus	University of Hamburg	DE	rasmus.revermann@uni-hamburg.de
Riahi	Mona	University of Marburg	DE	Riahi@students.uni-marburg.de
Richter	Anett	Helmholtz Centre for Environmental Research/ German Integrative Centre for Biodiversity Research	DE	anett.richter@idiv.de
Riechers	Maraja	Agroecology, Universität Göttingen	DE	Mrieche@hotmail.de
Ristok	Christian	MLU Halle; iDiv - MIE	DE	christian.ristok@idiv.de
Röder	Juliane	University of Marburg	DE	juliane.roeder@biologie.uni-marburg.de
Rodrigo	Ruffy	Georg-August-Universitaet Goettingen	DE	RODRIGORUFFY@GMAIL.COM
Rodríguez Zorro	Paula Andrea	Georg August University Göttingen	DE	paula.rodriguez@biologie.uni-goettingen.de
Rogers	Rebecca	Technische Universität München, Lehrstuhl für Terrestrische Ökologie	DE	rebecca.rogers@tum.de
Róis	Ana Sofia	ULHT	PT	rois.ana@gmail.com
Rojas	Juan	WWF	CO	juandiegore25@gmail.com
Rokitte	Katrin	Philipps-Universität	DE	katrin.rokitte@gmx.net

	Lea	Marburg		
Rose	Laura	Geobotanik - Uni Freiburg	DE	laura.rose@biologie.uni-freiburg.de
Rossetti	Maria Rosa	Universidad Nacional de Córdoba	AR	rossettimariarosa@gmail.com
Rüdisser	Johannes	Instut für Ökologie, Universität Innsbruck	AT	Johannes.Ruedisser@uibk.ac.at
Rudolph	Barbara	University of Hamburg	DE	barbara.rudolph@uni-hamburg.de
Ruehr	Nadine	Karlsruhe Institute of Technology	DE	nkruehr@gmail.com
Rühl	Anna Theresa	Justus Liebig University Giessen	DE	theresa.ruehl@umwelt.uni-giessen.de
Ruiz Albizuri	Jose Ricardo	Helmholtz-Zentrum für Umweltforschung (UFZ)	DE	ricardo.ruiz@ufz.de
Ruppert	Jan C.	Universität zu Köln	DE	jan.ruppert@uni-koeln.de
Rusch	Adrien	INRA	FR	adrien.rusch@bordeaux.inra.fr
Rusterholz	Hans-Peter	University of Basel	CH	hans-peter.rusterholz@unibas.ch
Saarinen	Timo	University of Helsinki	FI	timo.saarinen@helsinki.fi
Saha	Somidh	University of Freiburg	DE	somidh.saha@waldbau.uni-freiburg.de
Sahner	Josephine	Georg-August-University	DE	jsahner@gwdg.de
Sarmento Cabral	Juliano	University of Göttingen	DE	jsarmen@uni-goettingen.de
Sasaki	Keiko	Justus Liebig University	DE	Keiko.Sasaki@allzool.bio.uni-giessen.de
Sattler	Cornelia	Helmholtz-Zentrum für Umweltforschung – UFZ	DE	cornelia.sattler@ufz.de
Sauerbrei	Ralf	JLU Gießen	DE	Ralf.Sauerbrei@allzool.bio.uni-giessen.de
Scarano	Fabio	FBDS - Brazilian Foundation for Sustainable Development	BR	fscarano@fbds.org.br
Schädler	Martin	Helmholtz Centre for Environmental Research - UFZ	DE	martin.schaedler@ufz.de
Schäfer	Philipp	Universität Trier	DE	scha6e01@uni-trier.de
Schall	Peter	Forest ecology - Göttingen University	DE	pschall@gwdg.de
Scharf	Anne	MPI for Ornithology	DE	ascharf@orn.mpg.de
Scheepens	Niek J.F.	University of Tubingen, Plant	DE	johannes.scheepens@uni-tuebingen.de

		Evolutionary Ecology		
Schellenberg	Madlen	Institute of Ecology, Friedrich-Schiller University Jena	DE	madlen.schellenberg@hotmail.com
Scherer	Cédric	Universität Potsdam	DE	pscherer@potsdam.de
Scheu	Stefan	University of Göttingen	DE	sscheu@gwdg.de
Scheunemann	Nicole	University of Goettingen	DE	nicole.scheunemann@biologie.uni-goettingen.de
Schibalski	Anett	Universität Potsdam	DE	anett.schibalski@uni-potsdam.de
Schinkel	Christoph Carl-Friedrich	Universität Göttingen	DE	christoph-carl-friedrich.schinkel@biologie.uni-goettingen.de
Schittko	Conrad	Freie Universität Berlin	DE	conrad.schittko@fu-berlin.de
Schlaepfer	Daniel	University of Basel, Section of Conservation Biology	CH	daniel.schlaepfer@unibas.ch
Schleuning	Matthias	Senckenberg BiK-F	DE	matthias.schleuning@senckenberg.de
Schmidt	Anna-Lena	Georg-August Universität	DE	anna-lena1982@web.de
Schmidt	Johannes	IfGG, KIT	DE	johannes.schmidt@kit.edu
Schmidt	Markus	Hochschule für nachhaltige Entwicklung Eberswalde	DE	markus.schmidt@hnee.de
Schmidt	Anja	Helmholtz Centre for Environmental Research - UFZ	DE	a.schmidt@ufz.de
Schmidt	Marcus	Buesgen Institute - Soil Science of Tropical and Subtropical Ecosystems, Georg-August University of Goettingen	DE	marcus.schmidt@forst.uni-goettingen.de
Schmiedel	Inga	University of Göttingen	DE	inga.schmiedel@biologie.uni-goettingen.de
Schmitt	Christine	Center for Development Research (ZEF), University of Bonn, Germany	DE	christine.schmitt@landespflege.uni-freiburg.de
Schneider	Anne-Kathrin	Technische Universität Braunschweig	DE	anne-kathrin.schneider@tu-bs.de
Schön	Isa	Royal Belgian Institute of Natural	BE	isa.schoen@naturalsciences.be

		Sciences		
Schöning	Caspar	Freie Universität Berlin	DE	caspar@zedat.fu-berlin.de
Schröder	Birgit	Uni Rostock	DE	birgit.schroeder@uni-rostock.de
Schröder	Isabelle	Institute of environmental science, University landau	DE	isa_schroeder@web.de
Schröder-Esselbach	Boris	TU Braunschweig	DE	boris.schroeder@tu-bs.de
Schüler-Goldbach	Lisa	Department of Palynology and Climate Dynamics	DE	lisa.schueler@biologie.uni-goettingen.de
Schurr	Frank	University of Hohenheim	DE	frank.schurr@uni-hohenheim.de
Sciaini	Marco	Department of Ecosystem Modelling, University Goettingen	DE	sciaini.marco@gmail.com
Seage	Ramon	Institute of Evolutionary Ecology and Conservation Genomics. Ulm University	DE	ramonseage@hotmail.com
Seppelt	Ralf	Helmholtz Centre for Environmental Research (UFZ)	DE	Ralf.Seppelt@ufz.de
Settele	Josef	UFZ Halle	DE	Josef.Settele@ufz.de
Seyfullayev	Farid	Palynology and climate dynamics department	DE	fseyfullayev@yahoo.com
Shakeri	Zahed	University of Kurdistan	IR	shakeri.zahed@gmail.com
Sheppard	Christine Sabine	University of Hohenheim	DE	christine.sheppard@uni-hohenheim.de
Signer	Johannes	Georg-August-Universität Göttingen	DE	jsigner@gwdg.de
Silva de Oliveira	Deborah	Biozentrum Klein Flottbeck/Universität Hamburg	DE	deborahalani@gmail.com
Simons	Nadja	TU München	DE	nadja.simons@tum.de
Singh	Akanksha	Technische Universität München	DE	ga46jim@mytum.de
Soliveres Codina	Santiago	University of Bern	CH	santiago.soliveres@ips.unibe.ch
Somers	Ben	KULeuven	BE	ben.somers@ees.kuleuven.be
Sonnemann	Ilja	Freie Universität Berlin	DE	i.sonnemann@fu-berlin.de
Spatz	Theresa	Universität Marburg	DE	Spatz@students.uni-marburg.de

Staeps	Felix	Philipps-Universität Marburg, AG Naturschutzbiologie	DE	felix.staeps@posteo.org
Steckel	Juliane	University of Göttingen	DE	Juliane.Steckel@zentr.uni-goettingen.de
Stephan	Jörg	Swedish University of Agricultural Sciences, Department of Ecology	SE	jorg.stephan@slu.se
Steudel	Bastian	Geor-August Universität Göttingen	DE	bsteude@gwdg.de
Stiehl	Carolin	Frau	DE	cstiehl@gwdg.de
Stoltenberg	Kathrin	Universität Bremen	DE	stoltenberg@uni-bremen.de
Stretz	Carina	Universität für Bodenkultur, Wien	AT	carina.stretz@students.boku.ac.at
Sun	Shanwen	University of Bayreuth	DE	sunshanwen@gmail.com
Sun	Zhen-Kai	Institute of Botany,Chinese Academy of Sciences	CN	sunzhenkai@ibcas.ac.cn
Sundermann	Michelle	Northwest German Forest Research Station	DE	michelle.sundermann@nw-fva.de
Süßel	Florian	Institut für Pflanzenökologie	DE	Florian.Suessel@bot2.bio.uni-giessen.de
Sutter	Louis	Agroscope	CH	louis.sutter@agroscope.admin.ch
Swanepoel	Lourens	University of Venda	ZA	lourens.swanepoel.univen@gmail.com
Tamrakar	Rijan	Göttingen University	NP	rijan.tamrakar@forst.uni-goettingen.de
Tautenhahn	Susanne	Plant Biodiversity Group, Institute of Systematic Botany, FSU Jena	DE	susanne.tautenhahn@uni-jena.de
Taylor	Astrid	SLU, Uppsala	SE	astrid.taylor@slu.se
Taylor	Peter	University of Venda	ZA	peter.taylor@univen.ac.za
Teschke	Meike	Deutsche Forschungsgemeinschaft	DE	meike.teschke@dfg.de
Teuscher	Miriam	Georg-August-Universität Göttingen	DE	mteusch@gwdg.de
Thakur	Madhav Prakash	German centere for integrative biodiversity research	DE	madhav.thakur@idiv.de
Theodorou	Panagiotis	Martin-Luther-University Halle-Wittenberg	DE	panatheod@gmail.com
Thiele	Jan	WWU Münster	DE	Jan.Thiele@uni-muenster.de
Thill	Lisa	University Trier, Geobotany	DE	lisathill86@gmail.com

Thomas	Siegmar	Dresden University of Technology	DE	siegmar.thomas@mailbox.tu-dresden.de
Thorn	Simon	Bavarian Forest National Park	DE	simon@thornonline.de
Tiebel	Katharina	TU-Dresden	DE	Katharina.Tiebel@forst.tu-dresden.de
Tiede	Julia	Agroecology, Uni Goettingen	DE	jtiede@uni-goettingen.de
Tietjen	Britta	FU Berlin, Institute of Biology	DE	britta.tietjen@fu-berlin.de
Timpte	Malte	Museum für Naturkunde Berlin / NeFo	DE	malte.timpte@mfn-berlin.de
Treurnicht	Martina	University of Hohenheim, Institute of Landscape and Plant Ecology 320A	DE	martinatreurnicht@gmail.com
Trogisch	Stefan	Martin-Luther-University Halle-Wittenberg	DE	stefan.trogisch@botanik.uni-halle.de
Tscharntke	Teja	Agroecology Göttingen	DE	ttschar@gwdg.de
Tschumi	Matthias	Agroscope	CH	matthias.tschumi@agroscope.admin.ch
Tucker	Marlee	Senckenberg & Goethe Univ.	DE	marlee.tucker@senckenberg.de
Turrini	Tabea	UFZ / iDiv	DE	tabea.turrini@idiv.de
Twerski	Alina	University of Hamburg	DE	alina.twerski@web.de
Udy	Kristy	Georg-August-Universität Göttingen	DE	kudy@gwdg.de
Unger	Stephan	University Bielefeld	DE	stephan.unger@uni-bielefeld.de
Urban	Kira	Department of Forest Inventory and Remote Sensing, University of Göttingen	DE	kira.urban@stud.uni-goettingen.de
Uzman	Deniz	Hochschule Geisenheim University	DE	Deniz.Uzman@hs-gm.de
van Straaten	Oliver	Georg-August University of Göttingen	DE	ostraat@gwdg.de
van Toor	Mariëlle	Max Planck Institute for Ornithology	DE	mvantoor@orn.mpg.de
van Velzen	Ellen	University of Potsdam	DE	velzen@uni-potsdam.de
van Waveren	Clara-Sophie	Ecological Modelling Goettingen	DE	c.vanwaveren@web.de
Varga	Katalin	TU Bergakademie Freiberg	DE	varg.kata@gmail.com

Velasquez	Francisco	Technische Universität München	DE	franlucard@gmail.com
Verjans	Esther	Universität Hamburg	DE	esther.verjans@uni-hamburg.de
Vollhardt	Ines	Agrarökologie, Uni Göttingen	DE	ivollha@gwdg.de
von Buttlar	Jannis	MPI for Biogeochemistry, Jena, Germany	DE	jbuttlar@bgc-jena.mpg.de
von Witsch	Uta	German IPBES Coordination Office	DE	Uta.von-Witsch@dlr.de
Vosteen	Ilka	Max-Planck Institute for Chemical Ecology	DE	ivosteen@ice.mpg.de
Wagner	Katrin	University of Oldenburg	DE	ka.wagner@uni-oldenburg.de
Wagner	Sven	Institut für Waldbau und Waldschutz, TU Dresden	DE	wagner@forst.tu-dresden.de
Wagner	Thomas	Restoration Ecology, TUM	DE	wagner@tum.de
Walcher	Ronnie	Institute of Zoology, Department of Integrative Biology and Biodiversity Research, University of Natural Resources and Life Sciences, Vienna	AT	ronnie.walcher@boku.ac.at
Waldhardt	Rainer	Justus Liebig University Giessen, Landscape Ecology	DE	rainer.waldhardt@umwelt.uni-giessen.de
Walter	Theresa	BOKU / Vetmeduni Vienna	AT	theresa.walter@students.boku.ac.at
Walter	Julia	University of Hohenheim, Landscape and Plant Ecology	DE	walter.julia@uni-hohenheim.de
Waltert	Matthias	Georg-August-Universität	DE	mwalter@uni-goettingen.de
Warzecha	Daniela	Department of Animal Ecology	DE	daniela.warzecha@bio.uni-giessen.de
Wätzold	Marc	University of Hildesheim	DE	waetzold@uni-hildesheim.de
Wehnert	Alexandra	Dresden University of Technology	DE	alexandra.wehnert@freenet.de
Weibulat	Tanja	SNSB IT Center	DE	weibulat@bsm.mwn.de
Weigel	Robert	University of Bayreuth	DE	robert.weigel@geoecology.org
Weigelt	Patrick	University of Göttingen	DE	weigelt.patrick@gmail.com

Weise	Hanna	Institut für Biologie, Freie Universität Berlin	DE	hanna.weise@fu-berlin.de
Welk	Erik	Institute for Biology/Geobotany MLU Halle	DE	erik.welk@botanik.uni-halle.de
Welzel	Annika	University of Marburg	DE	annika.welzel@web.de
Wen	Yuan	University of Göttingen	DE	wyuan1025@gmail.com
Wende	Beate	University of Würzburg	DE	beate.wende@uni-wuerzburg.de
Wesche	Karsten	Senckenberg Museum Görlitz	DE	karsten.wesche@senckenberg.de
Westphal	Catrin	Agroecology, Georg-August-Universität Göttingen	DE	cwestph@gwdg.de
Wiedermann	Hauke	HAWK	DE	mail@haukewiedermann.de
Wiedey	Gustav	SWF im CBL der Uni. Göttingen	DE	gwiedey@gwdg.de
Wiegand	Daniel	JLU Gießen	DE	daniel.a.wiegand@posteo.de
Wiegand	Thorsten	Helmholtz Centre for Environmental Research GmbH - UFZ	DE	thorsten.wiegand@ufz.de
Wiegand	Kerstin	Uni Göttingen	DE	kwiegan1@gwdg.de
Wiesmair	Martin	University of Giessen ZEU	DE	martin.wiesmair@umwelt.uni-giessen.de
Wieczorek	Dorothee	Heinz-Nixdorf-Stiftungsprofessur für verteilte Informationssysteme Göttingen	DE	dorow.dw@gmail.com
Winter	Silvia	University of Natural Resources and Life Sciences Vienna	AT	silvia.winter@boku.ac.at
Wohlgemuth	Thomas	Swiss Fed. Research Inst. WSL	CH	thomas.wohlgemuth@wsl.ch
Wolf	Mariela	University of Würzburg	DE	mariela.wolf@uni-wuerzburg.de
Wöllecke	Jens	Ruhr-Universität Bochum	DE	jens.woellecke@rub.de
Wolters	Volkmar	Justus Liebig University	DE	volkmar.wolters@allzool.bio.uni-giessen.de
Wurst	Susanne	Freie Universität Berlin	DE	s.wurst@fu-berlin.de
Xu	Wubing	Institute of Botany, Chinese Academy	CN	xuwubing@ibcas.ac.cn

		of Sciences		
Yang	Nan	Büsgen-Institut	DE	nyang@gwdg.de
Yang	Xueqing	University of Hohenheim	DE	yangxueqing@mail.kib.ac.cn
Zaller	Johann	BOKU Vienna, Austria	AT	johann.zaller@boku.ac.at
Zaytsev	Andrey	Justus Liebig Universität Gießen IFZ – Abteilung Tierökologie	DE	Andrey.Zaytsev@allzool.bio.uni-giessen.de
Zhang	Naili	Institute of Botany, the Chinese Academy of Sciences	CN	597642423@qq.com
Zhang	Jie	Zoo III, Biozentrum, University of Wuerzburg	DE	jie.zhang@uni-wuerzburg.de
Zhu	Li	Institute of Botany	CN	julie@ibcas.ac.cn
Zhu	Yan	Institute of Botany, Chinese Academy of Sciences	CN	zhuyan@ibcas.ac.cn
Ziegenhagen	Birgit	University of Marburg	DE	birgit.ziegenhagen@biologie.uni-marburg.de
Zieger	Sarah	University of Goettingen	DE	szieger@gwdg.de
Zimmermann	Niklaus	Dynamic Macroecology, WSL	CH	niklaus.zimmermann@wsl.ch
Ziss	Elisabeth	BOKU Vienna Austria	AT	elisabeth.ziss@students.boku.ac.at
Zotz	Gerhard	Universität Oldenburg	DE	gerhard.zotz@uni-oldenburg.de
Zytynska	Sharon	TU München	DE	sharon.zytynska@tum.de