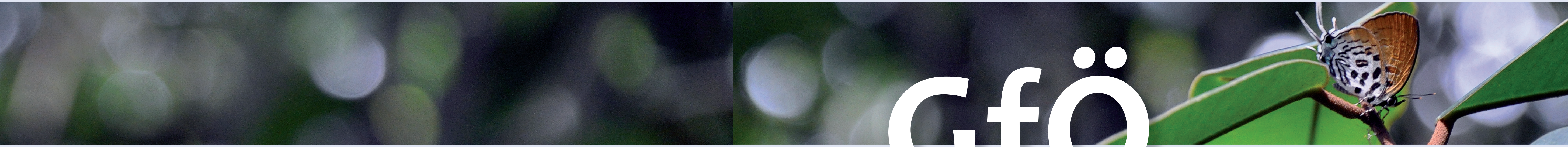

GfÖ

Book of Abstracts

Building bridges in ecology

linking systems, scales and disciplines

Verhandlungen

der Gesellschaft für Ökologie

Band 43

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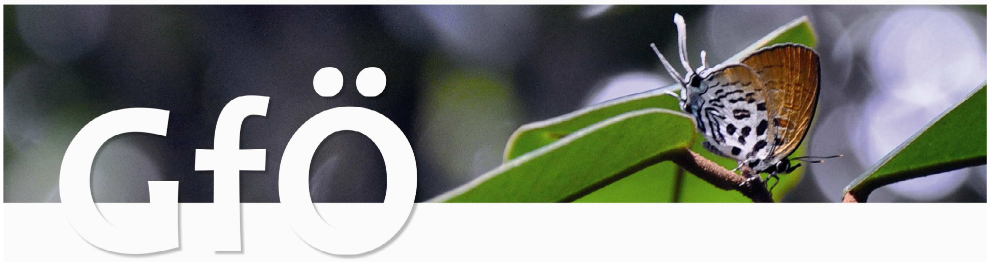

43rd Annual Meeting of the Ecological Society of Germany, Austria and Switzerland

Building bridges in ecology

linking systems, scales and disciplines

September 9 to 13, 2013
Potsdam, Germany

Key notes	Prof. Dr. Fernando Maestre Universidad Rey Juan Carlos Móstoles (Madrid), Spain
Prof. Dr. Dries Bonte Ghent University Ghent, Belgium	Prof. Dr. David Raffaelli University of York United Kingdom
Prof. Dr. Nicole van Dam Radboud University Nijmegen The Netherlands	William J. Sutherland University of Cambridge United Kingdom
Prof. Dr. Nelson G. Hairston, Jr. Cornell University Ithaca , U.S.A.	Prof. Dr. Lars Tranvik Uppsala University Sweden

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Book of Abstracts

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The 43rd annual conference of the Ecologcal Society of Germany, Austria and Switzerland (GfÖ) is taking place from the 9th to 13th of September 2013 at the University of Potsdam. Host of the conference is the Institute of Biochemistry and Biology of the University of Potsdam.

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The book is also available for download as electronic document on the conference web site for all registered participants: http://www.gfoe-2013.de/index.php?cat=program
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CONTENTS

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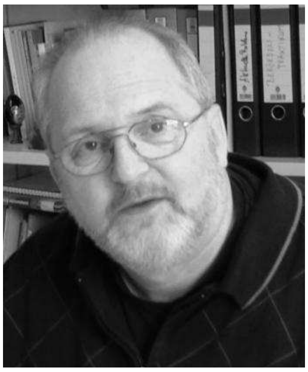
Dear friends and colleagues,



I cordially welcome you to the 43rd Annual Meeting of the Ecological Society of Germany, Austria & Switzerland (GfÖ) in Potsdam, the capital city of the federal state of Brandenburg. First mentioned in 992 A.D., Potsdam became a centre of immigration in Europe within the 17th century for people attracted by its intellectual tolerance and still pours on open minded atmosphere and cosmopolitan attitudes today. Visiting the Sanssouci palace, the Orangery or the Dutch Quarter, you will be amazed and inspired by the unique combination of historical grandeur and modern urbanity. The University of Potsdam has been founded in 1991 - only two years after the fall of the Wall. Together with the numerous extramural institutes located in the Potsdam-Berlin area, this young university belongs to one of the most active research regions in Germany. The Potsdam University is thus a perfect place for ecologists from all around the globe to convene at the GfÖ meeting, enjoying the amalgam of highly reputed keynote speakers, exciting sessions, stimulating workshops, thought provoking poster presentations and wonderful excursions. By taking a close look at the programme you will agree with me that the organizing committee has successfully managed to set the perfect stage for 'strengthening the scientific basis for sustainable development and biodiversity conservation'. I am very grateful to all the many people involved for making this conference possible.

Building bridges is not only a nice wording, but it is of vital importance for ecologists. First, because our scientific field forces us forging links between all levels of biological organization. Then, because we can only shoulder the enormous range of fundamental and applied research questions we are facing by using the full range of inter- and transdisciplinary approaches. And finally, ecologists can only succeed by forming closely-linked teams, which are ultimately tied together by both their enthusiasm about nature and their holistic view on life. This reminds me of another very important aspect of the GfÖ meeting: social contact and communication. What would be a scientific conference without the many - more or less - casual encounters of old buddies, new friends, and like-minded colleagues? With this in mind, I am looking forward to meet you in the friendly and stimulating atmosphere of Potsdam.

Volkmar Wolters

President of the GfÖ

Keynotes

Monday 13:30 – Signatures of Eco-Evolutionary Dynamics

Nelson Hairston[1]

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Over the past decade, it has become increasingly recognized that adaptive evolutionary change can be so fast that it may occur on the same time scale as ecological change. Since ecological processes drive natural selection, and evolving traits determine the strength of ecological interactions, evolution and ecology may be intimately linked in an eco-evolutionary dynamic. I will review studies from my collaboration with Steve Ellner and our research group that illustrate these processes. I will start with laboratory microcosm communities in which predator-prey cycling is radically altered when at least one of the species evolves as its environment changes. I will describe an analysis of published studies between 15 and 80 years old that, in retrospect, show evidence of eco-evolutionary predator-prey dynamics; suggesting the effects of rapid evolution on ecological processes may be common in the laboratory, even if previously unrecognized. Finally, I will describe methods for quantifying the relative importance of rapid contemporary evolution for the outcome of ecological processes. I will illustrate these methods with examples from natural populations which suggest that eco-evolutionary dynamics are also common outside the laboratory.

Tuesday 8:30 – Ecosystems and ecosystem services: the role of mainstream ecologists

Dave Raffaelli[1]

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To manage landscapes and seascapes sustainably in the face of global change, there has to be knowledge and understanding of the relationships between the stocks of natural capital and the flows of ecosystem services, how these relationships are likely to change under different plausible futures, as well as fit-for-purpose measures and indicators of both stocks and service flows. Society continues to demand flows from stocks of uncertain size and condition, often ignoring the trade-offs being made and possibly closing down future service provision. Yet our current knowledge and understanding of all these aspects is very poor. Here, I describe some of the science needs surrounding these issues and the contribution which can be made by mainstream ecologists to this challenging area

Tuesday 14:00 – Spiders in space: the metapopulation context of eco-evolutionary changes in dispersal

Dries Bonte[1]

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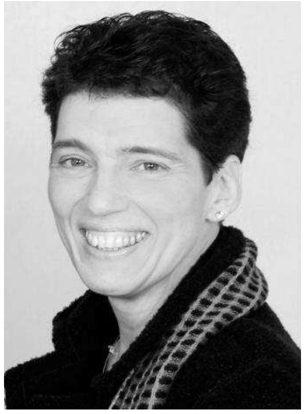
Dispersal is widely recognized as a key trait shaping species distribution patterns, connectivity and gene flow. Because dispersal is tightly coupled to fitness in spatially structured systems, it is –maybe more than other traits- subject to strong ecological and evolutionary dynamics. Despite the fact that the basic principles behind dispersal evolution are simple, the evolutionary dynamics in response to spatial, demographic and genetic variation in the environment remain poorly understood. Proper insights into the processes leading to heterogeneity in dispersal strategies and their ecological consequences are, however, essential for the development of conservation strategies that are resilient to climate change, including landscape management and assisted colonisation.

During this presentation, I will demonstrate the complex but fascinating interplay between evolutionary and ecological dynamics on dispersal in diverse arachnid species, and how it is principally determined by cost-benefit balances leading to fitness maximization. I will specifically highlight the impact of local demographic conditions and landscape structure on dispersal strategies, but also the hardly understood importance of transgenerational plasticity (maternal and even grandmaternal effects).

Dispersal consequently evolves in response to changes in metapopulation structure but simultaneously impacts the metapopulation dynamics. Because it is tightly integrated into individual life histories, correlated responses are expected leading to a strong covariation between dispersal and other traits. I will provide evidence from *in silico* (modelling) and *in vivo* simulation approaches using spider mites as a model system (experimental evolution in artificial metapopulations) that changes in metapopulation dynamics induce a clear divergence in dispersal and life history, with life history variation in temporally dynamic metapopulations inducing metapopulation rescue. Genomic approaches reveal exciting insights on the impact of spatial 'stress' on the adaptive potential when mites are challenged with novel environmental conditions.

Wednesday 8:30 – What comes up, must go down? Chemical and molecular mechanisms of Interactions between root and shoot feeding herbivores



Nicole van Dam[1]

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In natural environments, plants are attacked by a wide variety of root and shoot herbivores that both induce plant defence responses. These herbivore-induced defence responses are often systemic. Consequently, root feeding herbivores may affect the performance of shoot feeding herbivores, and *vice versa*. This, in turn, may have profound effects on both the aboveground and belowground communities that are associated with plants. In my presentation, I will show several examples of the chemical and molecular mechanisms governing aboveground-belowground interactions, especially in wild *Brassica* species. Chewing root herbivores, such as the larvae of the cabbage root fly *Delia radicum,* as well as piercing/sucking phytophagous nematodes have been found to affect the performance of aboveground herbivores. It was found that the effect on shoot feeding aphid populations is contingent on the feeding strategy of the nematode. Both primary (sugars, amino acids) and secondary compounds (glucosinolates) were analysed in leaves and the phloem to evaluate the role of plant chemistry in the observed effects on the aphids. Additional gene expression analyses showed that the presence of root feeding nematodes may significantly enhance the induced defence response to shoot feeding aphids. These analyses show that plant responses to herbivores are important mediators between aboveground and belowground communities associated with plants. Moreover, it shows that by ignoring the effect of belowground herbivores and other soil biota on aboveground plant defences we get only 'half the picture' of the complex interactions that plants manage in their daily life

Wednesday 14:00 – On the role of biotic communities as modulators of ecosystem responses to global change

Fernando T. Maestre[1], Santiago Soliveres[1], Manuel Delgado-Baquerizo[3], José L. Quero[2], Matthew A. Bowker[4], Enrique Valencia[1], Miguel Berdugo[1]

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[2]Universidad de Córdoba, Córdoba, ES
[3]Universidad Pablo de Olavide, Sevilla, ES
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Substantial research efforts are being devoted to predict how attributes of biotic communities such as species richness, composition and diversity will respond to global environmental change (GEC) drivers like climate change, land use change and increases in [CO_2] and nutrient availability. However, their impact on the relationships between biotic attributes and ecosystem processes is virtually unknown. Therefore, much remains unknown on the potential effects of GEC on the processes and ecosystem services that depend on biotic communities. This is particularly true for ecosystems such as drylands (arid, semi-arid and dry-subhumid areas), which cover over 41% of the total land surface and host ~38% of the global population.

In this lecture, I will summarize the results of recent and ongoing studies evaluating how biotic attributes (species richness, evenness and composition, cover and spatial pattern) modulate ecosystem responses (nutrient cycling and carbon storage) to GEC drivers(climate change, land use change and changes in the abundance of nutrients like nitrogen) in drylands These studies use multiple experimental approaches (manipulative and natural experiments), biotic communities (vascular plants and biocrusts dominated by mosses, lichens and cyanobacteria) and spatial scales (from local to global).

We found that the relative importance of biotic attributes such as plant cover or species richness as modulators of ecosystem responses to GEC drivers varies with the spatial scale considered, being more important at local and regional (~400 km) scales. At these scales, the effects of species richness on ecosystem functions were largely modulated by other biotic attributes, such as the total cover and spatial pattern of the plant/biocrust individuals. At the global scale, abiotic variables such as annual temperature or aridity largely determined the variation in functions related to carbon, nitrogen and phosphorus cycling, but attributes such as species richness and composition explained significant fractions of this variation. Overall, our results indicate that biotic attributes such as cover and species richness may partially buffer negative effects of GEC on ecosystem functioning in drylands.

Thursday 8:30 – Inland waters: subsidized by energy from terrestrial systems, and hot spots in the global carbon cycle

Lars J. Tranvik[1]

[1]Limnology, Department of Ecology and Genetics, Uppsala University, Sweden

Inland waters receive large amounts of organic matter from terrestrial systems, largely in the form of dissolved organic carbon (DOC). The energy bound in this organic matter is utilized by bacteria, and hence mobilized into to the aquatic food web. This process constitutes a substantial component of the global carbon cycle, and thus potentially affect climate as well. There is growing evidence that DOC, upon degradation by microbial and other processes, contributes substantially to evasion of carbon dioxide and methane to the atmosphere, but is also an important precursor of carbon that is buried in sediments. Accordingly, about half of the organic matter that reaches streams and lakes from the terrestrial environment is lost during transport down to the sea. This corresponds to an annual evasion of about 2 Gigatons of carbon dioxide from inland waters, an amount that is similar in size to the global oceanic carbon sink, or the annual loss of carbon to the atmosphere due to deforestation and land use change. DOC is a heterogeneous mixture of decomposition products, but the character and reactivity of DOC is not well understood and neither is what controls the molecular composition of this dynamic community of compounds. This presentation is an overview of the dynamics and fluxes of carbon involving DOC, from micro-scale to global scale.

Thursday 17:00 – Science Policy Exchange: Chances and Challenges

William J. Sutherland[1]

[1]Department of Zoology, University of Cambridge

I will argue that the current integration of science into policy making has serious problems, but that these can be improved. With the current approach, science and policy making can often be considered as separate activities with far less integration than could be achieved. I will describe how this could be improved and give examples of how we are actively trying to improve practice.

I will make the case for routine horizon scanning to identify the changes in technology, behaviour, environmental conditions and legislation that are likely to occur. The aim is to avoid the repeat of the problems associated with the USA and EU switching to encouraging biofuel production, which caused a series of ecological, climate change and social problems. This could easily have been foreseen.

Although one of the justifications of science is that it aids policy and practice, there has been remarkably little effort allocated to discovering what exactly would be of most use. We have run a series of collaborative agenda setting exercises that have proved to be surprisingly influential.

Following the success of evidence-based medicine we have been establishing a similar process with the objective of collating the available evidence to improve conservation practice. One objective is to bring the time for literature reviews of the evidence down from months to minutes. I will show how the adoption of this approach could have aided the restructuring of the Common Agricultural Policy to make it much more cost effective and that practitioners would regularly change practice if given access to published evidence that in theory is already available to them.

There seems to be a belief that the evidence will tell us what to do. I will argue that there is still a great gulf between what could ever be achieved in terms of collating the evidence and the decisions that practitioners need to make. I will describe a series of ways in which decision making could be improved to incorporate science more effectively.

SESSIONS –
ORAL AND POSTER PRESENTATIONS

Session 1 - Biodiversity dynamics: understanding communities across trophic levels

Chairs: Helmut Hillebrand, Christoph Scherber

O1 - Towards a trait-based understanding of interactions in species-rich plant communities

Frank Schurr[1,2], Henning Nottebrock[1,2,3], Baptiste Schmid[3,4], Karen J. Esler[3], Katrin Böhning-Gaese[4,5], Matthias Schleuning[4], Joern Pagel[1,2]

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[4]Biodiversity and Climate Research Center (BiK-F) and Senckenberg Gesellschaft für Naturforschung, Frankfurt/Main, DE
[5]University of Frankfurt, Frankfurt/Main, DE

A general understanding of species-rich or novel communities is unlikely to arise from a 'species-specific' approach that attempts to quantify all pairwise interactions between species. A promising alternative is a 'trait-based' research agenda that quantifies how variation in the performance of individuals is shaped by the interplay of biotic interactions and functional traits. Pursuing this trait-based agenda, we investigate (1) how the long-term growth rate of terrestrial plant individuals is shaped by interactions with neighbouring plants, and (2) how these interactions are determined by functional traits. To this end, we produced high-resolution maps of 28 shrubland communities in South African Fynbos, a global hotspot of biodiversity. These maps describe the precise location, species identity and functional traits of more than 230,000 shrub individuals. For 20,000 of these individuals, we additionally quantified long-term aboveground growth rate from measurements of individual size and age. These growth rate data are analysed with novel trait-based neighbourhood models that quantify how functional traits determine the direction, magnitude and spatial extent of plant-plant interactions. Such trait-based analyses constitute an important step towards a general understanding of community dynamics.

O2 - From Costa Rican bromeliads to the world: aquatic model systems for multitrophic biodiversity research

Jana Petermann[1]

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Even in times of dramatic species loss we struggle to explain the mechanisms behind natural diversity and to predict the consequences of extinctions for ecosystem function. Reasons for this poor performance are of course the sheer number of species, the complexity of their interactions and the dynamic nature of multitrophic communities. Therefore, reducing complexity to

manageable levels while retaining natural ecosystem properties is the foremost interest when choosing a model system for biodiversity research. Bromeliad plants provide small, naturally limited aquatic habitats by accumulating rain water between their leaves. Their inquiline organisms form relatively simple multitrophic metacommunities that can be examined along natural gradients. These systems can furthermore be used in manipulative field experiments and simplified communities can be rebuilt under lab conditions.

I will present results from Costa Rica where we use bromeliads to investigate coexistence mechanisms in protist communities. We conducted a survey and an experiment and found that water temperature and bottom-up control (resource input) are strong structuring forces of these communities while purely spatial effects and dispersal limitation played a minor role. We continue this research by testing the direct and indirect effects of environmental change along natural elevational gradients. We further examine temporal dynamics of these protist populations and communities in the lab.

A second project investigated the effects of species loss on multitrophic insect communities and their functioning. We found that bromeliad (i.e. habitat) size not only controlled species richness and biomass relationships between trophic levels but also modified the major ecosystem function, decomposition.

The natural environmental conditions and species composition of these small multitrophic aquatic communities in bromeliads facilitate the realistic upscaling of results to larger systems such as ponds and lakes.

O3 - Distinctive habitat preferences for major phytoplankton groups in a hypertrophic lake

Susanne Dunker[1], Karin Nadrowski[2], Torsten Jakob[1], Christian Wilhelm[1]

[1]University of Leipzig - Institute of Biology, Department of Plant Physiology, Leipzig, DE
[2]University of Leipzig - Institute of Biology, Department of Systematic Botany and Functional Biodiversity, Leipzig, DE

Complex interactions of environmental variables complicate the understanding of phytoplankton dynamic under hypertrophic conditions. For a better understanding of the interacting drivers of phytoplankton dynamics, a long-term data-set of a small hypertrophic lake in Leipzig (Auensee) was used a) to visualize the influence of multiple interacting environmental variables on phytoplankton groups and b) to estimate distinctive habitat templates.

Frequency distributions of each dominant phytoplankton group plotted against different environmental variables rendered distinctive habitat preferences for chlorophytes, cryptophytes, cyanobacteria and dinophytes. For example cyanobacteria frequently occurred as dominant group when nitrogen and light availability, as well as wind velocity were low and pH-values and temperature were high. In contrast, chlorophytes and cryptophytes were dominant groups if nitrogen and light availability were high and pH-values and temperature were comparatively lower.

These data suggest that the dominance of cyanobacteria in hypertrophic lakes may depend on a prior biomass accumulation resulting in high pH-values and low nutrient and light availability. The mechanistic cause of this hypothesis has to be proved in future but may explain the dominance of cyanobacteria under hypertrophic conditions based on a concretely defined ecological niche.

O4 - "Trophic overyielding": Phytoplankton diversity promotes zooplankton productivity

Maren Striebel[1], Gabriel Singer[2], Herwig Stibor[3], Tom Andersen[4]

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[2]WasserCluster Lunz, Lunz am See, AT
[3]Ludwig-Maximilians University Munich, Planegg-Martinsried, DE
[4]University of Oslo, Oslo, NO

Diversity–productivity relationships at the primary producer level have been extensively studied, especially for terrestrial systems. Here, we explore whether the diversity of aquatic primary producers (phytoplankton) has effects on higher trophic levels (zooplankton). We investigated the effect of phytoplankton diversity on an artificial zooplankton community in a laboratory experiment where phytoplankton biomass and elemental composition (carbon to-phosphorus ratio) were kept constant. Phytoplankton diversity increased the means of both zooplankton growth rate and abundance while suppressing their variability, and sustained higher zooplankton diversity. Likely explanations include resource complementarity effects among phytoplankton species as food entities, as well as niche complementarity effects among Daphnia species as competitors. By affecting the productivity as well as the variability of the next trophic level, biodiversity of primary producers may have far-reaching consequences in aquatic food webs.

O5 - Biodiversity effects in phytoplankton communities - combining experiments and modeling

Elias Ehrlich[1], Andrea Staudler[1,2], Guntram Weithoff[1], Ursula Gaedke[1]

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In terrestrial plants, diversity tends to enhance community biomass (overyielding) due to selection and/or complementarity effects. Laboratory experiments with phytoplankton suggested that the relationship between the growth rate and final monoculture biomass of the species determines the occurrence of under- or overyielding (Schmidtke et al. 2010). In our experiment, growth rates and final monoculture biomasses were mostly positively correlated implying that fast growing species

are productive and slowly growing species are unproductive. In batch cultures, productive species with high growth rates consume the resources quickly and prevent resource-intensive biomass production of slowly growing species promoting overyielding by a positive selection effect. We tested with a mathematical model considering only the selection effect, i.e. all species shared the same limiting resource. The model frequently matched the relative contribution of the individual species to community biomass well. It confirmed that over- and underyielding can be derived from the relationship between the growth rate and final monoculture biomass of the species. However, the model mostly underestimated the absolute values of community biomass indicating that the complementarity effect may be relevant in phytoplankton communities as well, e.g. when functionally dissimilar species with different limiting resources are members of the community. We conclude that with increasing species dissimilarity in resource use the complementarity effect may overrule the selection effect.

O6 - Trait-based plankton trophic interactions and community composition in a global ocean ecosystem model

F. Prowe[1], K.H. Andersen[1], T. Kiørboe[1], A.W. Visser[1], M. Pahlow[2]

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[2]GEOMAR, Kiel, DE

In many state-of-the-art marine ecosystem models of the open ocean, phytoplankton diversity is resolved comparatively well in terms of different plankton functional types governed bottom-up through resource use. This refined representation of the lowest trophic level contrasts with an oversimplified implementation of zooplankton characterized by rigid trophic interactions. Top-down control by zooplankton, however, may govern plankton community composition and diversity, thereby affecting ecosystem dynamics and food web structure. In order to assess potential effects of an improved representation of plankton communities, we present a new trait-based model of plankton interactions. Focusing on zooplankton feeding strategies and their trade-offs, this model explicitly resolves variable top-down control of the phytoplankton community. Coupled to a diverse phytoplankton assemblage in a global ocean ecosystem model, it aims at exploring effects of community composition on seasonal succession, plankton biogeography and trophic dynamics. Realistic physical forcing from a general circulation model captures environmental changes on various temporal and spatial scales. This setup allows us to compare communities emerging across trophic levels in different environmental regimes, and thereby assess the role of community composition for ocean ecosystem functioning.

O7 - Resource use efficiency and community turnover in phytoplankton and zooplankton communities

Helmut Hillebrand[1], Christopher T. Fisltrup[2], Adam J. Heathcote[2], W. Stanley Harpole[2], John A. Downing[2]

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In order to test relationships between biodiversity, ecosystem functioning, stability and temporal turnover, we analyzed a unique monitoring dataset containing phytoplankton and zooplankton community data from 131 lakes across Iowa, USA. In this agricultural region, we hypothesized that multitrophic freshwater communities with lower biodiversity would be less efficient in their use of limiting resources showed greater temporal species turnover. We found that phytoplankton resource use efficiency (RUE = biomass per unit resource) negatively related to phytoplankton evenness but positively to phytoplankton richness. In contrast zooplankton RUE was positively related to phytoplankton evenness. Phytoplankton RUE was high when cyanobacteria dominated, which also reduced phytoplankton species turnover, suggesting that cyanobacteria dominance may play important roles in ecosystem functioning and community stability in nutrient enriched lakes.

O8 - Indirect effects of plant species richness on the aphid endosymbiont community

Sharon Zytynska[1], Sebastian T. Meyer[1], Mohsen Mehrparvar[1], Sarah Sturm[1], Wolfgang W. Weisser[1]

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The species richness of a plant community is known to influence the composition and abundance of the associated herbivore community, and can have cascading effects on higher trophic species such as predators. Aphids feed on the nutrient poor phloem-sap of plants and host an obligate bacterial endosymbiont that provides the aphid with essential amino-acids not found in their diet. In addition to the obligate endosymbiont, aphids also host a number of facultative bacterial endosymbionts. These facultative endosymbionts are known to provide resistance to parasitoid wasps and fungus, and may be involved in host-plant utilization. In a natural system, a polymorphism is found for these facultative endosymbionts with individuals in a population hosting none, one or various combinations of these facultative symbionts. There can be a cost associated with hosting these symbionts and changes in the environment mean that selection pressure to host the symbiont varies over a season. We used the Jena biodiversity experiment to investigate the effect of plant species richness on the presence of six common facultative endosymbionts in aphids feeding on different host plants, using a PCR assay with species specific primers. Symbiont diversity and community composition was found to be influenced by the species richness of the plant community, although this also differed across aphid species on different plant hosts; e.g., for one host plant – aphid combination (hosting five different endosymbionts) we show that symbiont diversity is greatest at

intermediate plant species, whereas for another (hosting only two endosymbionts) there was no effect of plant species richness. We present this data to show that the biodiversity of the plant community can have repercussions not only on the herbivore community itself, but also on higher trophic levels associated with the herbivores. Analysing these indirect interactions may be crucial for understanding biodiversity effects on the plant community and ecosystem processes.

O9 - Arthropod's functional diversity along a plant diversity gradient

Anne Ebeling[1], Markus Lange[2], Michael Rzanny[1], Wolfgang W. Weisser[3]

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Shifts in plant species diversity have consequences for abundance and diversity of above- and belowground arthropods. Those changes propagate through trophic levels and also affect ecosystem processes, which are governed by them (e.g. herbivory, pollination, decomposition). Functional complementarity could be one mechanism leading to a positive relationship between arthropods species richness and ecosystem processes. However, studies analyzing the functional composition and diversity of arthropod communities under changing plant diversity scenarios are lacking.

In a grassland biodiversity experiment (1- 60 plant species), we addressed this gap by assessing aboveground arthropod communities (herbivores, omnivores, carnivores, parasitoids, and decomposers), their abundance, species richness and functional diversity. Eight years after establishment of the experimental plots, arthropods were collected across an entire growing season using pitfall traps and suction samples. Functional diversity (FD) was calculated by using different arthropod traits, e.g. body size, feeding guild, feeding specialisation, spatial niche and mobility (wing class). In addition community weighted means of each functional trait were calculated to analyse functional shifts within the arthropod community along the plant diversity gradient.

We identified a positive relationship between plant species richness and the functional diversity of arthropods, partly driven by their higher species richness. Interaction strength differed between arthropod groups and we further expect shifts in trait composition (e.g. higher mean body size of predatory groups in high diverse plant communities).

The results highlight the importance of including functional traits into the analysis of plant diversity – ecosystem function relationships.

O10 - Trait-based predator-prey dynamics with inheritance noise

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Mathematical models of classical predator-prey dynamics are formulated through systems of differential equations (spatially unstructured as ODEs or as PDEs when spatial aspects matter). The variables of the system describe concentrations of predator and prey species. Building a community from several species requires the addition of more variables to the system which leads to an unwieldy inflation of dimensionality. By contrast, a trait-based approach allows a much more efficient framework of description that is focused on representing functional diversity. In my presentation I will address a model formulation that allows to represent communities via trait variables and that is partly accessible to analytic treatment. The community structure evolves dynamically according to trait dependent interactions. In this context, inheritance noise is added to the framework of description which models the influence of genetic variability on community structure. Numerical simulations show that apart from stable structured communities also oscillations of total biomass and/or community structure can be observed.

O11 - Herbivore defenses of tropical tree species increase across a rainfall gradient

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In highly diverse lowland tropical forests, species distribution patterns vary across moisture and nutrient gradients. Besides direct effects of available resources, biotic interactions, especially herbivores, are thought to play an important role in structuring tropical forests. Under more humid conditions that favor high insect abundance, plant species that have evolved efficient herbivore defenses should have an advantage and be more abundant that species with low defenses. However, little is known about variation of herbivore pressure and plant herbivore defenses across environmental gradients in the tropics. Here, we tested the hypothesis that herbivore defenses of tropical woody species increase with their association to wet forests, reflecting a pervasive role of herbivores in driving species distributions patterns. Furthermore, we tested relations with shade tolerance and differential associations to nutrient availability, as well as with various plant functional traits.

We assessed herbivore defenses for 74 woody species with known distribution patterns along a rainfall gradient at the Isthmus of Panama through dual choice tests. A preference index for each of the plant species against a reference plant (*Ixora coccinea)* was determined for the generalist caterpillar *Spodoptera frugiperda*. We related the preference index to the distribution of the species across the rainfall gradient, as well as to distributions across soil nitrogen, phosphorus and potassium gradients. Effects of plant traits (shade tolerance and deciduousness) and mechanical leaf traits (SLA, occurrence of hairs and latex) on the preference index were assessed.

As hypothesized, effectiveness of herbivore defenses significantly increased with plant association to wet forests. It decreased with association to high soil phosphorus content, possibly because leaf phosphorus contents increased, making leaves more attractive to arthropods. Herbivore defenses were not related to associations to nitrogen and potassium. Contrary to previous studies, leaf herbivore defenses decreased with shade tolerance. Preference was neither affected by the mechanical defenses assessed nor by deciduousness, suggesting that phytochemical defenses play a more important role in this system.

Our results indicate that herbivores and plant defenses against them are an important driver in shaping plant distribution and diversity patterns along tropical rainfall gradients.

O12 - Species richness patterns in temperate deciduous forests are not correlated within or across trophic levels

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High diversity in lower trophic levels should lead to an elevated diversity in higher trophic levels due to a greater supply of possible niches. This should also apply to richness relationships in local communities if these mechanisms were relevant compared to other factors influencing community assembly.
In temperate forests, soil fauna contributes the major part of species richness of local communities, but the factors influencing richness patterns of soil animals are only poorly understood. Strong positive correlations among richness of groups of different trophic levels would indicate that trophic interactions might considerably affect community assembly and thus richness of potentially interacting taxa.

We analysed whether species richness of 9 soil animal groups (Lumbricidae, Oribatida, Collembola, Coleoptera, Gastropoda, Isopoda, Opiliones, Chilopoda, Diplopoda) and corresponding plants assessed on 64 forest plots distributed over Baden-Württemberg co-varied among groups. Datasets of mixed-diet groups (e.g. Coleoptera) were subdivided according to trophic behaviour of the species. Overall, data of >1000 species were analysed.
To analyse alternative causes for richness correlations among groups, we calculated the effects of environmental and climate variables and took into account spatial correlations.

In general, we found that cross-correlations among the observed taxa were weak (mean R^2=0.07, max. R^2=0.36). Taking into account the number of statistical tests, none of the richness correlations among taxa between trophic levels were significant (exception: of plants vs. herbivorous Coleoptera). Also, richness correlations of taxa within trophic levels were weak. Environmental and climate variables influenced the species richness of the taxa differently. The species richness patterns were highly idiosyncratic for each group.

We conclude that trophic interactions are of minor importance for the richness patterns of local assemblies in temperate deciduous forests.

O13 - Arthropod diversity in highly diverse subtropical forest ecosystems in south-east China

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Arthropods play a prominent role in the functioning of most terrestrial ecosystems. In subtropical forests, arthropods act simultaneously as herbivores, predators and decomposers. Despite the fact that there is a wide spectrum of trophic groups, guilds and species, until now little is known about the species diversity of different arthropod taxa in highly diverse forest ecosystems.

Research was conducted in 27 comparative study plots (CSPs), embedded in the framework of BEF China. CSPs are located in subtropical forests in the Gutianshan National Nature Reserve (Zheijang Province, South-East China). Plots are representative for different woody species richness (25 – 69 trees and shrubs per plot) and a successional gradient of forest stand age. To assess the three functional groups decomposer, herbivore and predator species, macrofauna was sampled with 108 pitfall traps across the growing season from March to September 2009.

The following groups were identified up to species or morphospecies level: Araneae, Formicidae, Chilopoda, Diplopoda, and Isopoda as well. Identification of Coleoptera species is still in process. The aim is to investigate whether there is a clear correlation between animal species diversity of the given taxa and successional stage or woody plant species diversity.

O14 - Bottom-up controlled and correlated effect of logging on tripartite plant-animal mutualistic networks

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Mutualisms linked through shared plant resources may show a bottom-up controlled and correlated response to habitat degradation. We assessed the effects of logging and fragmentation on tripartite interactions between ten fleshy-fruited plant species and their pollinators and seed dispersers by combining information theoretic and phylogenetically informed analyses. Our results suggest that logging, but not fragmentation, increased the number of partners that plants had in the mutualism with pollinators and substantially reduced the number of partners and interactions in the mutualism with seed dispersers. Despite these apparently contrasting responses logging had a correlated effect on interactions of specific plants with their pollinators and seed dispersers. Importantly, the response of pollinators followed species specific shifts in plant density in logged forest, whereas plant species with short fruiting seasons were most susceptible to a loss of seed dispersers. These results suggest non-idiosyncratic and bottom-up controlled effects of habitat degradation on interconnected plant-animal mutualisms.

O15 - Predicting plant fecundity from spatiotemporal variation in sugar landscapes

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Pollinator-mediated biotic interactions among neighbouring plants determine spatial variation in plant fecundity and thus influence community dynamics. These pollinator mediated interactions are assumed to be affected by the spatial and temporal distribution of floral resources, such as nectar production. Yet, very little is known about the spatiotemporal distribution of floral resources in real-world ecosystems, i.e., the spatiotemporal variability of "sugar landscapes", and about how these sugar landscapes determine plant fecundity. To close this gap of knowledge, we initiated an extensive study in a global biodiversity hotspot (South African Fynbos). Our aims were (1) to quantify sugar landscapes from the spatial and functional composition of plant communities, and (2) to test whether sugar landscapes influence seed set. To this end, we produced high-resolution maps of 28 communities in which 23 serotinous *Protea* species co-occur in different compositions and at different densities. Amongst more than 230,000 mapped shrubs, we selected 2,500 individuals for which seed set, as well as various plants, leaf, inflorescence and nectar traits were measured. We use novel trait-based Bayesian neighbourhood models to quantify sugar landscapes and their effects on seed set. This trait- and resource-based framework sheds new light on how plant-pollinator interactions shape the dynamics of plant communities.

P1 - Below- and aboveground diversity effects on productivity in experimental plant communities

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While plant species richness is known to be positively linked to ecosystem processes such as productivity, there is accordant evidence that soil biota can also play an essential role by affecting diversity, growth and community composition of plants. Despite the significance of microbial diversity for ecosystem functioning, interactions between plant and soil biota diversity on plant productivity have been rarely addressed, and even less is known about how abiotic factors can influence this above- and belowground interplay.

We conducted a multi-factorial greenhouse pot experiment to assess effects 1) of plant diversity, 2) of reduced soil fungi or bacteria and 3) of the light environment on the productivity of plant communities. Using a species pool of six cosmopolitan herbaceous plant species (*Bidens frondosa*, *Celosia argentea*, *Melochia corchorifolia*, *Oenothera biennis, Phytolaccaamericana*, *Solanum nigrum*), we created experimental plant communities at three diversity levels (1-, 2- and 4-species mixtures). In a full factorial design, the communities were exposed to different soil microbial biota compositions induced through selective inhibition of soil microorganisms by applying a fungicide and bactericide as separate and combined treatments. In addition, we applied two light levels (full light and reduction to 30% light) by using two types of shading nets to simulate different levels of canopy coverage.

Plant growth is being continuously monitored as a proxy for temporal dynamics of aboveground community productivity. Biodiversity dynamics across trophic levels will be addressed by studying feedback effects of plant diversity and productivity on soil communities. Using PLFA-analysis, we will analyze composition and biomass of soil biota communities.

The poster will present first results of this experiment, highlighting the importance of below- and aboveground components of diversity-ecosystem function relationships when studying productivity of plant communities.

P2 - Stoichiometry of plant-animal interactions along an experimental biodiversity gradient

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In the face of anthropogenic alterations of biodiversity, we need to disentangle the mechanisms underlying biodiversity-ecosystem function relationships, which can profit from investigating multi-trophic interactions, ecological stoichiometry and species-specific responses to changes in diversity. This study analyzed the stoichiometric response of three host plant species and their aphid herbivores to changes in plant biodiversity and composition. Plants and phloem sap feeding aphids were sampled in a grassland experiment (Jena trait-based experiment) with manipulated gradients in species richness and functional diversity. From the three plant species, only *Centaurea jacea* showed a significant stoichiometric response to plant diversity with low C:N ratios in redundant plots and high C:N ratios in plots with functionally complementary species. The relationship between plant and aphid stoichiometry differed between species pairs, but only one pair (*Anthriscus sylvestris* and *Aphis fabae*) exhibited a significant positive correlation in C:N ratios. Aphid colony density decreased with increasing plant C:N values, possibly indicating the ability of aphids to locate high quality food. In conclusion, plant diversity and identity influenced plant stoichiometry, which in turn at least partly influenced aphid colonization and C:N ratios.

Session 2 - Linking plant ecology and agricultural applications - Ecophysiological and ecosystem processes in agro-systems

Chairs: Maik Veste, Werner B. Herppich

O1 - Ecophysiological traits related to the growth response of maize and sorghum to drought and free air CO_2 enrichment

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Given the future increase in temperature and the decrease in summer precipitation, sorghum could be an alternative energy crop besides maize due its better drought tolerance. However, it remains open how future elevated atmospheric CO_2 concentrations ([CO_2]) may affect these interactions. To address this question different sorghum cultivars and one maize cultivar were grown in the field under different levels of water (well-watered and dry) and CO_2 supply (ambient and +210 ppm) using free air CO_2 enrichment (FACE) technique combined with rain shelters. The dry treatment received half as much water as compared to well-watered treatment. The objectives of the study were to investigate whether there is genetic variation in the growth response of the sorghum cultivars to the treatments and whether sorghum cultivars perform better than maize under drought and elevated [CO_2].

We found that maize performs better than sorghum under all growth conditions and there was a variation in the growth response to the treatments among the sorghum cultivars. This was due to differences in growth parameters namely light absorption by the green canopy and radiation use efficiency of biomass production (RUE). Leaf growth of sorghum was slightly delayed in early summer as compared to maize, which resulted in differences in seasonal light absorption. Under wet conditions, RUE was highest for maize and varied among the sorghum cultivars, which seemed to be related to differences in cold tolerance. Analysis of stomatal density and leaf gas exchange suggest that maize has a more efficient transpiration and water use than sorghum. Consequently, maize is better adapted to the prevailing German weather conditions and thus had a higher biomass yield than sorghum. This higher growth potential leads to a high water demand and hence the water savings under elevated [CO_2] can be transformed in additional biomass production under limited water supply.

O2 - Resource capture traits of C4 energy crop rooting systems under elevated CO_2 and limited water supply

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Climate change will impact the growth of cultural plants, due to increasing atmospheric CO_2-concentrations [CO_2] and higher frequency and length of dry periods. C_4-plants are considered as to be better adapted to future stress situations. Especially Sorghum exhibits a high drought stress tolerance due to the vigour and resilience of its root system. Thus sorghum cultivars are considered as suitable crops to mitigate climate change on energy crop production. However, research on the effects of increasing [CO_2] and drought stress on the root system of sorghum and maize under conditions of Central Europe has not been done by now.

At the Thünen-Institute in Braunschweig, root growth of two sorghum cultivars, 'Bulldozer' (*Sorghum bicolor*) and 'Inka' (*Sorghum bicolor* x *Sorghum sudanense*) and one maize cultivar 'Simao' (*Zea mays*) was studied in experimental rings under high [CO_2] simulated by a Free Air Carbon dioxide Enrichment (FACE) equipment (600 ppm CO_2) (3 rings) and ambient [CO_2] (3 rings). For simulation of drought conditions one semi-circle of each ring was equipped with rainout-shelters in contrast to sufficient soil moisture conditions in the other semi-circle. At harvest, soil samples were taken down to a depth of 110 cm. Characteristics of the root system (root length density (RLD), specific root length (SRL), etc.) were determined by scanning of sampled roots and analyzing with the computer programme WinRhizo.

For the maize genotype an increase in RLD and rooting depth in soil layers lower than 60 cm was detected when [CO_2] was elevated, whereas no reaction was found for the sorghum genotypes. All genotypes reacted with an increase in SRL in soil layers lower than 60 cm under elevated [CO_2].

Due to increasing SRL caused by elevated [CO_2] root acquisition of water and nutrients may be enhanced for sorghum and maize. In general the adaption of sorghum genotypes to drought where better compared to maize, because rooting depth and total root length were higher.

O3 - Isoscapes and arbuscular mycorrhizal fungiscapes in relation to wheat yield

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Heterogeneity is the basis of ecosystem function in agricultural landscapes. Industrial agriculture, however, increases homogeneity at field and landscape scales which often leads to a reduction of ecosystem function. Within the agricultural landscape laboratories (AgroScapeLabs; www.scapelabs.org) we investigate among others relationships of in-field heterogeneity and agroecosystem functions. Our objective was to relate in-field heterogeneity in wheat fields with agroecosystem functions that facilitate plant growth, like nutrient cycling and arbuscular mycorrhizal fungi (AMF) abundance.

We quantified in-field heterogeneity by using a biomass-index measured using a tractor-based sensor and we characterized nitrogen (N) processes and water use efficiency using δ^{15}N andδ^{13}Carbon (C) isotopic signatures of soil and plants. We developed spatially interpolated maps for δ^{15}N isotopic signatures of soil and wheat plants (isoscapes) and water use efficiency of wheat plants, and maps for AMF abundance (“AM-fungiscapes”) using Geographical information system (GIS). To determine the impact of nutrient processes and AMF abundance on wheat yield at field scale, iscoscapes and “AM-fungiscapes” are related to real wheat yield measurements. High AMF abundance is expected to be positively related to water-use efficiency and yield of wheat plants. δ^{15}N isotopic signatures of wheat plants and soil at field scale describe plant-soil N processes and may link to AMF abundance and wheat yield.

Manipulating agricultural management towards an increase in agroecosystem function may enable a reduction in agricultural inputs, which can consequently improve the ecological sustainability of agroecosystems.

O4 - Use of different AMF strains to alleviate salt stress in *Sorghum bicolor* and *Medicago sativa*

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Salt toxicity is one of the major edaphic factors limiting crop production and eco-environmental quality in saline and/or sodic soils throughout the world. Soil restoration has a potential to sequester Soil Organic Carbon (SOC) and that adoption of recommended management practices can increase SOC concentration in salt-affected soils. We assessed the effect of saline stress on AM fungi and its relationship with soil microbial activities, and if inoculation with AM fungi can confer salinity tolerance to crop plant and that such tolerance is correlated with changes in the soil aggregation and with a higher diversity of AM fungi. For this purpose we carried out a greenhouse-experiment with *Sorghum bicolor* (L.) Moench and *Medicago sativa* L. with different levels of salinity and different isolated strains/communities. Salinity decreased root and shoot biomass of both plants. The AMF strain *Funneliformis coronatum* (Giovann.) C. Walker & A. Schüßler isolated from a salt marsh could alleviate salt stress in *S. bicolor* plants, but the inoculation with an AMF community was less effective as expected. AMF inoculation could not cope salt stress in *M. sativa* plants. Phosphatase activity in soil decreased with increasing salinity, in which AMF could partly compensate it. Dehydrogenase activity was increased by AMF inoculation due to the C shift from plant to soil.

O5 - Degradation-resistant antibiotics delay germination and growth of two crop plant species

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Especially in factory farming, veterinary antibiotics are increasingly used to prevent the outbreaks of diseases that would otherwise occur in large animal populations confined to small places. Through the use of manure as fertilizer in agriculture, crop species can be exposed to veterinary antibiotics, especially if these are degradation-resistant. So far, little is know about the effects of antibiotics on crop species performance and subsequently on higher trophic levels such as pollinators or seed predators.

In a greenhouse experiment, we exposed ten individuals each of rapeseed (*Brassica napus*) and red clover (*Trifolium pratense*) to different concentrations (1 – 50 mg antibiotic / kg soil) of two degradation-resistant veterinary antibiotics, which are commonly used in cattle and poultry factory farming. Antibiotics were added to the soil once before seeds were planted, to simulate manure fertilization before planting in agricultural fields. Additionally, a control of ten individuals each of both species was planted without adding any antibiotics.

Interestingly, both plant species reacted differently to the addition of antibiotics. Red clover did not show significant differences in germination and growth performance, when the control and both antibiotics treatments were compared. For rapeseed, time until germination was significantly prolonged and shoot growth significantly decreased with increasing antibiotics concentrations. The decrease of shoot growth was more severe in treatments where a combination of two antibiotics was used.
These first results show that even small traces of antibiotics in the soil can lead to drastic changes in germination and growth performance of some crop species, which might subsequently not only affect yield but may also have consequences for animal interaction partners such as pollinators or seed predators.

O6 - Ecological impact of Camelina sativa and Thlaspi arvense cultivation in a summer double cropping system in Northern Germany

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Rising food and energy demand in combination with limited land resources has given rise to an urgent need for novel cultivation concepts that increase productivity in a sustainable manner. In a random block field experiment we compared the ecological impacts of two novel, short-rotation oil seed crops, *Camelina sativa* and *Thlaspi arvense*, to fallow and conventional cover crop (legume-oat mix) cultivation between August and September 2012 in Northern Germany.

Initial results indicate that there was no significant difference between cultivation systems in greenhouse gas emissions (CO_2, N_2O, CH_4), soil nutrient status (N, P, K), microbial biomass, soil water content and soil temperature. There were, however, large differences in the C and N contents of above and belowground biomass as well as total biomass production itself (both above and belowground). As a result total C and N uptake was significantly higher in the cover crop and *Camelina sativa* treatments compared to the fallow and *Thlaspi arvense* treatments.

We conclude that small differences in short-term ecological impacts are masked by large inherent variation of the systems analysed. The clear difference in biomass production is, however, likely to have long-term effects on soil chemical and bio-physical properties as well as on the total greenhouse gas balance. This warrants further medium to long-term research into such novel cropping systems but does not imply that the short-rotation cultivation of *Camelina sativa* and *Thlaspi arvense* is unsustainable *per se*.

O7 - Tree water use and productivity along a gradient of soil water availability in a short rotation coppice plantation in Brandenburg, Germany

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Woody biomass from short rotation coppice (SRC) plantations is increasingly gaining importance as a renewable source of biomass and energy. In Brandenburg, NE Germany, a large proportion of the farmed area is characterized by either dry sandy soils on slopes and ridges or seasonally inundated loamy soils in depressions. Also, the area receives only little precipitation during the growing season (≤ 300 mm). Therefore, a deep-rooting, woody plant cover in SRC systems may offer benefits over traditional agricultural crops. Nevertheless, the productivity of SRC may vary greatly depending on soil type, nutrient and soil water availability.

To assess the relationship between water supply, plant water use and productivity we selected a 5-year old poplar plantation along a slope from drier hilltop to moist, temporarily inundated downhill conditions. 20 trees of the clone 'Max1' (*Populusmaximowiczii x P. nigra)* were equipped with sap flow probes and monitored continuously during the growing season 2012. Concomitantly, the water status of several trees was monitored continuously with leaf patch clamp pressure probes. The trees were harvested during the following winter to quantify the biomass and to determine the productivity-based water use efficiency.

Over the growing season, the volumetric soil water content in 30−100 cm depth decreased by 9−11 % on the drier upper slope and hilltop while only by 5−7 5 % at the lower slope. The diameter range of the trees studied along the slope was 5−12 cm (1 m above ground), the total height 5.6−11.2 m. The aboveground dry woody mass of the harvested trees ranged from 1.8 to 13.6 kg (excluding bark) while the dry mass accumulated during the growing season 2012 was estimated to vary between 0.3 and 7.4 kg. Average daily tree water use amounted to 0.5−9.6 kg d^{-1}. These findings and further results will be discussed in terms structure-function relationships of tree water use and water use efficiency.

O8 - Short-rotation culture with *Salix*: Finding drought adapted genotypes

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Salix is a promising crop for bioenergy use and has a better energy balance than most annual energy crops. Until now, breedingof *Salix* increased its biomass yield by 60 %. However, the breeding history of willow is short and therefore there is great potential for crop improvements. Particularly in regard to global warming the drought tolerance of energy crops is becoming more important as well as the efficient use of nitrogen as both characteristics are directly linked to key physiological processes and biomass accumulation.

In the project “Salix Molecular Breeding Actions (SAMBA)” (www.samba-webb.se) we are analysing the drought effects for 474 genotypes each replicated 6-fold in a field experiment in Sweden. The same design with identical genotypes was established in Northern Italy with an irrigated and non-irrigated treatment. In order to analyse the water economy of the plants, we will apply a dual isotope approach for the assessment of water use efficiency ($\delta^{13}C$), transpiration rate ($\delta^{18}O$) and assimilatory capacity (ratio of the two $\delta^{13}C/^{18}O$) in leaves and year rings.

The overall goal is to support breeding development by identifying ecophysiological traits which are relevant for maintaining or increasing biomass yield at decreased water use. The presentation will give insights on former findings of the SAMBA project and introduce the methods of the forthcoming analysis.

O9 - Biomass production in agro-systems: Is black locust (*Robinia pseudoacacia* L.) the right choice?

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Currently, black locust (*Robinia pseudoacacia* L.) is an important tree species in Central and Eastern Europe for the production of biomass in short-rotation plantations. Being a ruderal species and relatively drought tolerant compared to other broad leaf trees, its use in agroforestry systems will increase. That is particularly true for marginal landscapes characterized by adverse edaphic conditions, where the soil water availability is limited and in summer drought can occur. Several studies have been carried out on the subject of the black locust primary production; however there are still open questions associated with its water consumption and the biomass production, in relation to the soil water availability. In order to investigate the soil-plant-atmosphere system interactions, in our studies the links between the growth rate, water use efficiency and the ecophysiological response have been examined in a two year lysimeter experiment. The two years old black locust plants were selected from a recultivated post-mining area (Welzow Süd, Lusatia, Brandenburg) and established in a 100 L wicked lysimeter, installed under a light transmissive roof to avoid uncontrolled water input. During the first vegetation period, the trees were maintained constantly under three different soil moisture regimes (well-watered, moderate, drought), in relation to the hydrostatic state of the lysimeters. For the second vegetation period instead, the plants were subjected to two different irrigation cycles (long term drought stress, short term drought stress), in relation of the drought stress and recovering time duration. The results were satisfactory. At whole plant level the water use efficiency, the growth rate under different soil moisture conditions and the morphological adaptation to drought condition were assessed. In addition, at leaf level we elucidated the relation between the soil moisture together with the atmospheric evaporative demand and the ecophysiological performance in terms of H_2O and CO_2 rate variation. From the results emerged that the black locust cultivar may have a positive or negative effect on the ecosystem function, depending on the water availability of the areas in object. The tree can tolerate periods of drought by reducing its transpiration rate, yet it is not to be considered a water saving trees species in a well watered condition.

O10 - Water stress and sapling establishment of hybrid poplar grown in short rotation energy plantations on contaminated soils

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Alternative land resources like power lines, railroad embankments and industrial fallows are targeted in Brandenburg to grow energy plantations to avoid conflict with conventional food crops. With the phasing out of the premium for fallows in 2010 short rotation coppice became a feasible option for former sewage plantations. In Deutsch Wusterhausen, the planting of 160 ha of poplar and black locust was initiated. Restrictions due to space limitations and nature conservation regulations complicated conventional vegetation management.

This study focused on sapling development of poplar during the first three years of establishment with special emphasis on the influence of ground vegetation on tree vitality. Competing vegetation is identified to be a major factor aggravating water stress, hampering the establishment of young saplings, causing mortality rates of >60% during the first year. Trials were set up to proof water shortage and investigate if sapling vitality could simply be improved by reducing water stress. These trials were planted as rods (60 cm) and cuttings (20 cm). Glyphosate was applied before planting to remove all vegetation from *no competition* treatments. We recorded soil moisture as well as in situ climate data. Establishment and vitality of saplings was checked during the first two months and again in fall. We recorded bud appearance, number of shoots, damages, height and diameter. After the season 10 plants per treatment and species were dug up in plastic tubes to assess root system development.

Findings of field inventories were also verified in a glasshouse experiment, where water use was quantified for the dominant grass species *Elymus repens* and for poplar as well as their complementary water use when grown together. The water supply in poplar lasted 106 days and first signs of water stress were noted after 55 days. If grown with grass water lasted about half the time and first signs of drying in poplar were observed after 36 days.

Grass competition has proven to increase water stress conditions during the establishment phase under site conditions in Brandenburg, where soils with low water storage capacity and a precipitation of 250 mm during the growing season are prevailing.

O11 - Tolerance of fast-growing tree species to flooding and waterlogging: ecophysiological responses & growth performance

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The northeastern lowlands of Germany, in particular the federal State of Brandenburg, feature an undulating landscape whose mildly elevated parts can be prone to drought (during dry spells), whereas gentle depressions may tend to waterlog (after heavy or prolonged periods of rainfall). As one of the predicted impacts of climate change, annual precipitation in this region will be less evenly distributed throughout the year which, in combination with fairly high water tables at many sites, can lead to waterlogging in depressions. While annual crops are severely affected by waterlogging, short-rotation coppice of fast-growing tree species has shown to be a competitive alternative land use option on these specific sites. Data assessments on plantations and in trials have revealed great differences in performance and tolerance of poplar and willow varieties. Preliminary results lead to the assumption that water chemistry plays a crucial role. Survival rates of young poplar and willow under controlled experimental flooding indicate that even very young plants (> 12 months) can tolerated several months of flooding, provided that soil and water chemistry are suitable. In practice however, poplars suffered an almost complete dieback at one study site after only a few weeks of flooding, where the water contained particularly low nitrate and high nitrite concentrations, indicating redox reactions. On the contrary, poplars of another plantation survived flooding during more than 12 months, where water chemistry appears to have been suitable for tree survival and continued growth performance. Ecophysiological responses of the trees to the prolonged flooding included: leaf chlorosis, early leaf shedding, and adventitious rooting. Height increment was significantly reduced when the inundation lasted through the second vegetation period; nevertheless the trees were still alive and growing.

O12 - Nutrition of fast growing tree species and effects of land use change on agricultural soils

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The ongoing emission of CO_2 due to burning of fossil fuels and global warming give new impulses to replace fossil raw materials by renewable biomass as sustainable alternative. Since a few years short rotation plantations (SRP) of fast-growing tree species on agricultural land are becoming -after a long tradition in the tropics and subtropics- an additional component in energy and material supply chains also in Central Europe. Besides aspects of energy and material use the storage of carbon in trees and soils of SRP is an additional benefit stabilizing climatic and environmental conditions.

Typically fertilizer and organic residue application ensure a sufficient nutrient supply of agricultural crops. Land use change from intensively managed annual crop to wood production in SRP generally does not require fertilization. In the case of biomass production on forest sites the amount of nutrient export with harvest is low as mainly stems with a low concentration of nutrients are used and branches and twigs with higher concentrations are left on site. Because of the high growth rates of trees in SRP systems and the use of smaller trees with bark and twigs, the export of nutrients is increased in SRP compared to traditional forestry.

The present investigation tries to assess the sustainability of current management practice on SRP. Thus the storage of plant-available nutrients in soils and organic layers is compared with nutrients accumulated in the biomass that is exported every 3–4 years due to harvest.
With low ratios of nutrient content in the soil to nutrient content in the harvested biomass, addition of fertilizer in the form of recycled ashes from wood combustors was found to be beneficial for tree growth. The addition of ash as well as the input of detrimental elements, such as heavy metals or an excess of nutrients, affect the nutrient status of the soil and thus need to be included in the nutrient balance to ensure the sustainability of such management practices.

O13 - Potential ecological impacts of miscanthus, a prospective bioenergy crop, in agro- and natural ecosystems

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Miscanthus is considered to be one of the most economically promising perennial grass species for biomass and bioenergy production in Europe. Currently only one sterile allopolyploid clone, *Miscanthus x giganteus,* is used commercially. The main limitations to its cultivation in Europe are high establishment costs and poor over-wintering capability in colder climates. There are several high-yielding miscanthus species and interspecific hybrids which have the potential to overcome the existing bottlenecks in miscanthus production. Many of these produce viable seeds in temperate climates allowing more effective breeding and reducing establishment costs. This also means that new miscanthus varieties able to reproduce both vegetatively and by seed, to outcross and which are more resistant to environmental stresses may enter agricultural fields in the future.
Miscanthus possesses many ecological traits typical of highly invasive species, such as no or few resident pests, vegetative propagation, the formation of dense monospecific stands, rapid growth, high water- and nutrient-use efficiency and large seed production. Moreover, some miscanthus species exhibit allelopathy in their natural environments. Miscanthus is a relatively new bioenergy crop in Europe and information on its invasive potential and impacts on biodiversity under temperate climate conditions is limited.
Within the framework of the EU-funded project OPTIMISC (FP7), fitness responses of several miscanthus genotypes and accessions to various environmental scenarios are assessed. Performance of miscanthus genotypes is evaluated in two grassland communities on marginal and nutrient-rich land in South Germany. The potential of miscanthus to spread by seed and rhizomes, to withstand competition and persist in grassland communities and in crop stands, as well as its allelopathic properties and effects on biodiversity in grasslands are assessed in several field trials and experiments under controlled conditions.

P1 - Yield, transpiration and growth of the new bioenergy crop IGNISCUM Candy under different water regimes

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There is a growing global need to produce more energy and reducing greenhouse gas emissions. One possible source of renewable energy in parts of Europe is the use of crop for bioenergy production. Currently, maize dominates the biogas production. For a diversified production of substrates alternative crops needs to be evaluated for their sustainable utilization and ecological integration into agro-systems. The new bioenergy plants IGNISCUM Candy and IGNISCUM Basic are cultivars of the Sakhalin Knotweed (*Fallopia sachalinensis*, Fam. Polygonaceae), which are characterized by a high annual biomass production. Information on the crop production of this species is rare. Hence, understanding plant response to the combinations of water and nutrients availability is crucial for the development of sustainable plant production. In greenhouse experiments we investigate the interrelations between nutrient supply, biomass production, and plant ecophysiology. For the determination of yield-transpiration relations at whole plant level we used a wick lysimeter system, which allows us to study plant growth under controlled water regimes and to calculate the plant transpiration. The irrigation is supplied by an automatic drip irrigation system and computer-controlled in relation to the volumetric soil water content. Four different water treatments associated to the SWC range from well-watered to drought stressed plants. The influence of plant sizes on plant water use was investigated under different nitrogen supply. The fertilizer applied is calcium ammonium nitrate (N) and the rates for the four treatments are 0, 50, 100, 150 kg N/ha at the beginning of the growing season. Plant transpiration is calculated on the basis of water input, storage and drainage in weekly intervals. The cumulative transpiration of the plants during the growing season is between 49 L (drought stressed) and 141 L (well-watered) per plant, respectively. We calculated a transpiration coefficient of 525 Liters per kg dry biomass.

P2 - Black locust (*Robinia pseudoacacia* L.) root growth response to different irrigation regimes.

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Robinia pseudoacacia L. is a pioneer tree species native from North America. Its original range is a climatic region classified as humid to sub-humid, with a mean annual precipitation of 1020 to 1830 mm. However, it grows under a wide range of edaphic and climatic conditions and the species has proven to be relatively drought tolerant. In central Europe, with a continental climate, the species has been successfully cropped for biomass production also on marginal land, even in post-mining areas characterized by water limitation and harsh edaphic conditions. Due its drought tolerance, fast resprouting rate and its ability to live in symbiosis with Rhizobia and thus fix atmospheric nitrogen, black locust could become a key species for short-rotation plantation on marginal land. Several studies have been already carried out to quantify the black locust above ground production and its water use efficiency. However, the relation between the black locust biomass allocation, root system development and plant water use has still to be examined. In our study we evaluated the drought stress effect on black locust below ground biomass production, root distribution, and the

root and rhizobial association. Different irrigation regimes were chosen to test the plant's performance in a lysimeter experiment, under semi-controlled environmental conditions, for the duration of two vegetation periods. From the results obtained we determined the root biomass allocation under different irrigation regimes and identified the close relation between the soil water condition and the rhizobial association.

P3 - The Giant Reed (*Arundo donax*): Ecophysiological investigations and its potential use for bioenergy production

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The Giant Reed (*Arundo donax*) is a common and widespread species in the Mediterranean countries, especially in Italy, Spain Portugal and Greece. The plant has been introduced to the area and is invasive in the entire countries. *Arundo* is naturally growing along river banks, creeks and road sites. There are some evidences that the plant can even grow under saline conditions. Due the high potential biomass production the plant is of interest to use it for bioenergy production. The use of the biomass for bioenergy production can also bring income to the costly control of the species in the area. For the use of biomass for bioenergy the chemical composition of minerals are also very critical. A high chloride and nitrogen content is critical for the burning. We investigated the ecophysiological adaptations of different populations from freshwater wetlands to the seashore sand dunes in Central Portugal. The potential use for bioenergy production will be discussed.

P4 - An approach to understand what drives carbon allocation in beans (*Phaseolus vulgaris*)

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Changing environmental conditions are expected to change source and sink strength for carbon. Enhanced CO_2 concentrations for example increase photosynthetic activity and, therefore, source strength, while increased soil temperatures lead to increased sink strength. Knowledge about the influence of source and sink strength on carbon allocation and thus the yield is crucial under climate change conditions.

We performed a $^{13}CO_2$ pulse-labeling experiment with eight weeks old beans (*Phaseolus vulgaris*) with mature pods, where sink and source strength were systematically manipulated after labeling. Source strength was reduced by lowering irradiance and sink size was reduced by cutting half of the pods. Furthermore, the same treatments were applied to plants under nitrogen deficit. Plants were destructively harvested during the chase period of three days.

The percentage of total carbon in leaves is diminished under low light conditions as photosynthesis is reduced. Furthermore, the direct coupling of photosynthesis and root respiration is indicated by the tendency to reduced root respiration rates under low light conditions. The total carbon content in the pods is only influenced by nitrogen supply, but not by decreasing light intensity or cutting of the pods. In combination with the same amount of ^{13}C label in the pods independent on source and sink strength, this leads to the conclusion that transport of recently fixed carbohydrates from the leaves to the sinks is neither purely source or purely sink driven. Most of the ^{13}C label is transported into the pods, having priority in carbon allocation compared to roots. Altogether, the driving force is the supply of the priority sink, the pods, with carbon – independent of the sink or source strength.

Knowledge about plant physiology and the internal carbon cycle of plants can help to adapt and improve agricultural strategies to increase yield under climate change conditions.

P5 - Climate Extremes - A Free-Air Temperature Enrichment System to induce Heat Stress on Wheat

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Temperatures above 30°C in certain sensible phenological stages have pronounced negative impacts on the grain set and yield of wheat (Asseng et al. 2011, Barnabas et al. 2008). Projections of anticipated climate change predict altered rainfall conditions, an elevated atmospheric CO_2 concentration and particularly increases in both average temperatures and temperature extremes (Solomon et al. 2007), with the latter being most detrimental to cereals like wheat. Current predictions of future wheat yields under growing conditions that include more frequent and extreme heat waves still rely on data mostly derived from plants that have been grown under artificial experimental conditions like greenhouses or climate chambers. In order to obtain results on heat stress impacts on the yield of wheat under realistic field conditions, a free-air experimental facility using infrared ceramic heaters was set up at the Thünen Institute in Braunschweig. The facility comprises 12 circular plots for temperature enrichment, each with a diameter adjustable to 1.5 – 3.0 m. By having no surrounding walls side-effects of the experimental set-up on microclimatic conditions are largely avoided. The increase in temperature by the infrared heaters is concentrated at the upper canopy layer of the wheat canopy where the heat stress effects on grain set and yield take place. In the years 2014 and 2015, the free-air temperature enrichment facility will be used in combination with a large-scale free-air carbon dioxide enrichment (FACE) system to study the interaction of heat stress and elevated CO_2 on wheat.

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P6 - Effects of oviposition by *Manduca sexta* on *Nicotiana attenuata* on the induction of plant defences and larval performance

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Plants can use signals that indicate future herbivory to accelerate anti-herbivore defence induction. It is well known that plants can take volatiles released by herbivore-infested neighbouring plants as a signal of future herbivory, and then respond faster and stronger to herbivory. Because egg deposition by an herbivorous insect could be a reliable signal for plants to prepare for attack by the feeding larvae, we investigated whether eggs laid by the tobacco hornworm *Manduca sexta* may prime anti-herbivore defences in the wild tobacco *Nicotiana attenuata*. In greenhouse experiments, we compared larval performance on egg-free and previously egg-laden pants and measured several chemical and molecular defence parameters of egg-laden and egg-free plants before and after larval feeding. Some secondary metabolites (e.g. caffeoylputrescin) were induced more strongly by larval feeding in egg-laden compared to egg-free plants. We found egg-mediated effects on the transcriptional regulation of genes involved in herbivory-related phytohormone signalling before and an altered induction of phytohormones after larval feeding. The egg-primed changes in induced secondary metabolites did not affect larval growth parameters, but the antimicrobial activity in the hemolymph of larvae on egg-laden plants was reduced. This indicates that egg-primed induced defences may result in an immunosuppression of the herbivore, and thus harm the herbivore.

Session 3 - Food-web ecology in aquatic and terrestrial systems

Chairs: Herwig Stibor, Björn C. Rall

O1 - Copper and Zinc as food enhancers for detritivores: is metal pollution bad?

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Even though research keeps unveiling more information about processes in soil systems, relatively little is known about food web interactions at the first trophic level. Direct interactions, such as who eats what, are widely described using various methods, however, limitations of essential nutrients, other than the macro nutrients C, N and P, is poorly known. It is hypothesized that detritivores can only sustain and grow when essential nutrient intake exceeds a certain threshold value. Previous findings have shown that detritivores are not in an elemental balance with their food. We assessed if elevated concentrations of the heavy metals (copper and zinc) cause changes in body stoichiometry of essential nutrients. We investigated mismatches between litter and consumers from three sites (Cu-polluted, Zn-polluted and reference) and studied the implications of elemental imbalances (e.g., delayed growth). We collected samples of four soil and litter dwelling macro-invertebrate taxa using pitfall traps, and pine litter was collected from the forest floor at the same plots. We analyzed concentrations of 13 elements both in litter and animals. Using animal body mass, consumption rates and elemental concentrations in food and consumer we estimated the time needed for animals to reach maturity. For many nutrients unrealistically long growth periods were found. Changes in nutrient concentrations at the polluted sites resulted for a variety of elements in lowered growth periods, but remained longer than the life expectancy. The results suggest that next to the more often mentioned negative ones there are positive effects of metal pollution. Nevertheless, the change in elemental concentrations did not result in more realistic growth periods, indicating that other factors, such as selective feeding, over feeding and supplementary feeding, play an important role in nutrient acquisition by detritivorous macro-invertebrates.

O2 - Which factors affect prey choice of soil predators? Examining variations in trophic interactions using molecular gut content analysis

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Soils harbor an exceptional variety of organisms, which are linked to each other via trophic pathways forming complex food webs. The structure of these webs is shaped by strength and connectivity of trophic links between consumers and resources which still are largely unknown as conventional analysis methods such as microscopic gut dissection are not applicable. PCR based molecular gut content analysis allows identifying prey spectrum and feeding preference of generalist predators which predominate in soil. Centipedes are among the most prominent predators in belowground systems reaching high numbers in litter and soil of temperate forests. We investigated impact of a set of environmental and biological factors on prey choice of *Lithobius* sp. (Lithobiidae, Chilopoda) across a land-use gradient in two regions in Germany. We used a set of specific PCR assays targeting abundant prey taxa to study trophic interactions of lithobiid centipedes. Results show that prey choice is driven by habitat structure and prey abundance, while land-use has no effect. Additionally, we found predator body size to strongly affect feeding of centipede predators. Overall, the results suggest that strength and direction of trophic links depend on interaction of a variety of factors, stressing that feeding ecologies of predators to be studied comprehensively.

O3 - Contributions of climate warming, predator feeding and oxygen depletion to timing and rates of metamorphosis of an aquatic larva into a terrestrial adult

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Aquatic and terrestrial systems are often linked functionally by flows of nutrients and organic matter as well as by the exchange of organisms. The habitat shift of chironomids during their metamorphosis of an aquatic larva into a terrestrial adult, a process mediated by the pupal stage, gives the group a key role in coupling aquatic and terrestrial ecosystems. We analysed the interplay of bottom-up (temperature, oxygen) and top-down forces on the timing and rates of emergence of chironomid key species over a five-year period. Catches of chironomids in near-bottom pupal traps and floating emergence traps exposed in a deep temperate reservoir were combined with diet analyses of an omnivorous top predator (perch). At elevated spring temperatures, higher spring densities of profundal pupae and an earlier start of emergence were determined. Changes in the pupation peak period corresponded to a seasonal shift in the feeding specialization of perch to chironomid pupae, thereby predation losses increased to 50-65% of daily emergence. During flood events, terrestrial ecosystems export larger amounts of organic and anorganic matter to the metalimnetic layer resulting in a horizon with oxygen depletion. As a consequence, the rates of emergence of chironomids that inhabit this depth horizon as larvae were significantly reduced. As indicated by the results of this study, a more integrated view of organisms with complex life histories is needed to understand the whole-ecosystem energy flows.

O4 - Aquatic prey subsidies to riparian spiders in different land-use-systems

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Habitat degradation in freshwater ecosystems has considerably increased over the past decades due to anthropogenic land use, which has affected the aquatic but also the riparian community. Previous studies have shown that aquatic emergent insects can contribute substantially to the diet of riparian predators. However, these studies have mainly been performed in undisturbed ecosystems. To evaluate the effect of land use on aquatic prey subsidies of riparian spiders we performed a longitudinal study along a first order stream (Rhineland-Palatinate, Germany) covering three land-use types: forest, meadows and vineyard. Using stable isotopes analyses of aquatic emergent insects and terrestrial arthropods, we determined the contribution of aquatic and terrestrial resources to the diet of web-weaving (Tetragnathidae) and ground-dwelling (Lycosidae) riparian spiders.
Results show that riparian spiders consumed different proportions of aquatic and terrestrial sources between land-use types. This was especially evident for Tetragnathidae which consumed 80-100% of aquatic insects in the meadows and only 45-65% in the forest and vineyards. We discuss hypotheses for the shifts in the proportions of consumed food sources and possible relations with land use.

O5 - Whole-lake experiments reveal the fate of terrestrial particulate organic carbon in aquatic food webs including its return to the surrounding terrestrial environment

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Lake ecosystems are strongly linked to their terrestrial surroundings by material and energy fluxes across ecosystem boundaries. The contribution of terrestrial particulate organic carbon (tPOC) to lake food webs and its subsequent return to terrestrial surroundings has not yet been adequately traced and quantified. We conducted a whole-lake experiment and added maize leaves as an isotopically distinct carbon tracer into one half of a turbid lake and one half of a clear-water shallow lake, each divided by a curtain. During the subsequent year, carbon isotope values for benthic macroinvertebrates and omnivorous fish were significantly higher with maize additions than in the reference side of each lake, demonstrating experimentally that tPOC is incorporated up to higher trophic levels of lake food webs. The food web of the clear-water lake with abundant submerged vegetation did not exhibit a higher reliance on tPOC, despite its higher structural complexity in littoral zones, which we hypothesized would facilitate the transfer and processing of tPOC. Emerging insects transferred part of the added tPOC back to terrestrial food webs (riparian spiders), indicating a close terrestrial-aquatic coupling.

O6 - The differential fate of additional allochthonous organic matter in the pelagic and benthic food chain

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The input of allochthonous organic matter (AOM) into aquatic ecosystems is predicted to increase. Bacteria and primary consumers represent the most likely entrance channels of AOM into the lake food web, but so far quantitative evidence is scarce. We conducted whole-lake experiments to quantify the fate of AOM addition into shallow lakes of differing alternative stable states. Both lakes were divided into two parts and maize leaves were added to one half of each lake. Stable isotope analyses suggest that a substantial fraction of the added maize is channeled to macroinvertebrates and omnivorous fish (cf. talk by Scharnweber *et al*.). Ciliates which dominated within the zooplankton community in these lakes, increased in biomass after maize addition and their composition changed to more bacterivorous species. In Gollinsee the change in composition outweighed the biomass increase thus the phytoplanktivorous ciliate biomass was reduced. Thus with rising AOM input the feeding pressure on phytoplankton and epiphytes may decrease which may enhance the probability of lakes to become more turbid and to loose macrophytes. The biomass of copepods which are presumably the main consumers of ciliates, was frequently too low to efficiently consume the high ciliate biomass. This suggests that the additional resource was hardly channeled to higher trophic levels via the pelagic food chain.

O7 - Stochastic top-down control explains variability of aquatic macrophyte biomass

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[1]Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, DE, hilt@igb-berlin.de Nutrient-mediated bottom-up control of periphyton has often been suggested to determine the biomass of submerged plants in shallow lakes. This process is, however, not compatible with theories of

alternative stable regimes requiring unpredictability. Our studies in the temperate Lake Müggelsee during re-oligotrophication revealed that interannual variation in submerged macrophyte biomass was related to changes in periphyton shading caused by stochastic changes of its top-down control cascading from planktivorous fish via periphyton-grazing invertebrates. Changes in the abundance of juvenile planktivorous fish were assessed based on the assumption of a negative correlation with the abundance of the cladoceran predator *Leptodora kindtii*. Our results indicate that in years with low *L. kindtii* and thus high abundance of juvenile fish, the latter graze down zooplankton during the clear-water phase and subsequently switch to periphyton-grazing invertebrates. This results in high periphyton biomass in June negatively affecting macrophyte biomass by shading. In contrast, years with a high *L. kindtii* abundance were indicative for lower predation pressure on periphyton grazers resulting in high macrophyte biomass. Under sufficiently eutrophic conditions, interannual changes in the abundance of juvenile omnivorous fish can thus be decisive for macrophyte biomass and deliver the stochasticity required for alternative equilibria in shallow lakes.

O8 - Thresholds for sterol-limited growth in a freshwater key herbivore

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The determination of dietary threshold levels at which essential nutrients become limiting is crucial for assessing nutritional constraints under field conditions. Besides elemental nutrients, such as phosphorus and nitrogen, many animals rely on an adequate dietary supply with a number of essential biochemicals, among them certain polyunsaturated fatty acids (PUFAs) and sterols. As yet, thresholds for sterol limited growth have been recorded only for cholesterol, the predominant body sterol in most animals. In general, cholesterol is hardly represented in plant material and thus herbivorous animals have to cope with the various phytosterols present in their plant food sources. To assess potential differences in the suitability of typical phytosterols to support somatic growth of *Daphnia*, we offered ten different phytosterols as dietary supplements along with a sterol-free food source to juvenile *D. magna* in a concentration-dependent manner. Somatic growth rates in response to dietary sterol concentrations and thresholds for sterol-limited growth were evaluated comparatively. In addition, the concentrations of individual sterols in animal tissues were determined to obtain information on sterol metabolic constraints and bioconversion capacities of *D. magna*. The results revealed significant differences among phytosterols in supporting *Daphnia* growth and this will help to assess dietary threshold levels at which sterols become limiting in the field.

O9 - Food-web ecology in aquatic and terrestrial systems

The coupling of anti-predator defences in Daphnia: the importance of light

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Daphnia occupy a central role in freshwater systems especially as important prey for planktivorous fish. Chemical cues released from fish (kairomones) induce multiple defences in *Daphnia*, among them diel vertical migration (DVM) and life-history (LH) changes, which have a strong impact on the food web. Many genotypes of *Daphnia* are capable of using both DVM and LH, and it remains unclear if and how the induction of both defences within a given genotype is regulated in order to avoid multiple costs. Here we show that the induction of LH changes by kairomones is suppressed in the absence of light. Using qPCR we further show that the expression of putative target genes is affected by kairomones, and this effect is modulated by the presence of light. In conclusion we propose that DVM modulates the level of light an individual *Daphnia* is exposed to and thereby determines the extent of LH changes in response to kairomones.

O10 - Warming, enrichment and predator-prey body mass ratios help shape complex food webs

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Past investigations showed that warming and enrichment, (i.e., ecosystem fertility), two important drivers of species loss, are likely to interact with each other and with predator-prey body masses. Here, we use a dynamic population model to assess the effect of temperature, fertility and predator-prey body mass ratios on species persistence and link distribution in complex food webs. The biological parameters of our model are parameterized with empirical body mass and temperature scaling relationships. We found that body-mass ratios, temperature and fertility interactively affect species persistence and link distributions.

Body-mass ratios are not only a major determinant of the effect of both temperature and food web fertility but also in influence the relative extinction risk of generalists and specialists. Our results can help disentangling the complex effects of climate change and build theory that can then be tested in the field.

O11 - Benchmarking successional progress in a quantitative food web

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Central to ecology and ecosystem management, succession theory aims to mechanistically explain and predict the assembly and development of ecological communities. Yet processes at lower hierarchical levels, e.g. the species and functional group level, are rarely mechanistically linked to the under-investigated system-level processes which drive changes in ecosystem properties and functioning and are comparable across ecosystems. As a model system for secondary succession, seasonal plankton succession during the growing season is readily observable and largely driven autogenically. We used a long-term dataset from large, deep Lake Constance comprising biomasses, auto- and heterotrophic production, food quality, functional diversity, and mass-balanced food webs of the energy and nutrient flows between functional guilds of plankton and partly fish. Extracting population- and system-level indices from this dataset, we tested current hypotheses about the directionality of successional progress which are rooted in ecosystem theory, the metabolic theory of ecology, quantitative food web theory, thermodynamics, and information theory. Mean body mass, functional diversity, predator-prey weight ratios, trophic positions, system residence times of carbon and nutrients, and the complexity of the energy flow patterns increased during succession. In contrast, both the mass-specific metabolic activity and the system export decreased, while the succession rate exhibited a bimodal pattern. The weighted connectance introduced here represented a suitable index for assessing the evenness and interconnectedness of energy flows during succession. Diverging from earlier predictions, ascendency and eco-exergy did not increase during succession. By embedding aspects of functional group composition and diversity into the context of the metabolic activity and food web complexity, we reconcile previously disjoint bodies of ecological theory and provide a benchmark for quantifying successional progress in other ecosystems.

P1 - Land use affects the energy transfer across the freshwater-land interface

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Freshwater ecosystems subsidize adjacent terrestrial ecosystem through emerging aquatic (merolimnic) insects. While recent studies have established catchment and riparian land use as important predictors of population and community endpoints, the relevance of land use for cross-system fluxes remains open. In this study, we evaluated the influences of land use on merolimnic species abundance and biomass and estimated the energy transfer to land at four different scales – the catchment scale and three riparian corridors. The land use was derived from Corine 2006 land cover data and the merolimnic species data originated from governmental monitoring of the German states and covered the whole of Germany. The abundance data was used to estimate biomass fluxes using size-mass relationships and autecological information from the Freshwater Ecology database. The proportion of forest was related to the abundance and biomass of merolimnic species richness for all spatial scale, where the catchment scale showed highest influence. Land use was a stronger predictor of aquatic biomass than abundance and therefore significantly affected the energy transfer to adjacent terrestrial systems. We discuss the relevance of our findings with respect to the effect of aquatic food web dynamics on the functioning of terrestrial systems.

Session 4 - Biodiversity and ecosystem services in cultural landscapes

Chairs: Stefan Hotes, Fred Jopp, Izumi Washitani

O1 - Managing the Commons sustainably - is the ecosystem service concept the key?

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Cultural landscapes comprise a variety of ecosystems with different degrees of human impact. Although much of these landscapes is privately owned and managed, ecological processes across the entire area contribute to ecosystem functioning and ultimately to the delivery of ecosystem services. Recognition that human well-being at the individual level and at the level of communities depends on adequate management of these landscapes has led to a renaissance of the term 'commons'. The use of the term implies that interest in their sustainable use extends to society at large; this in turn means that governance systems are needed to help balance competing types of use. At this general level there is broad agreement about these issues, but deriving concrete guidelines for policy development is a constant challenge. Traditionally, there has been a divide between approaches based primarily on (local) experience with actual land management schemes and more theory-based, scientific approaches that try to integrate larger bodies of data to discover general patterns. Debate about the ecosystem service concept in the context of sustainable land management over the past years has highlighted the need for both approaches to be reconciled. This paper reviews examples of regulatory and incentive-based schemes aimed at sustainable land use in Europe and Japan, examining indicators for their relative success and exploring possible ecological, social and economic determinants that influence how well they perform. It concludes with suggestions for making the ecosystem service concept amenable to contrasting socio-ecological systems.

O2 - Site-based trans-disciplinary approaches for sustainable land use in biosphere reserves

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Trans-disciplinary approach is a keyword of recent environmental issues including Convention on Biological Diversity. To make a solution of balance between biodiversity conservation and sustainable use of natural resources, we need knowledge of ecology, economy, and law. We also need local/traditional knowledge and the sense of business and leadership. However, the dialog of the scientists of a different field is often too abstract, and will become unproductive. I usually recommend using case studies for trans-disciplinary approach. Scientists use their scientific

knowledge and any knowledge that are available. They realize that their own knowledge is definitely short for finding solution of the case study. Therefore trans-disciplinary approach is needed in site-based management. I introduce a short history of Japanese case studies in Shiretoko Natural World Heritage (WH), Yakushima Biosphere Reserve (BR) and Aya BR. In Shiretoko WH, when the scientific council (SC) for Shiretoko WH was organized in 2004, few social scientists were included in the SC. I personally invited a socio-economist as an observer. He is an expert of fisheries co-management because IUCN requested increase of conservation level in the marine area of Shiretoko WH site. We described fisheries co-management in Shiretoko and advised fishermen to increase conservation effort by themselves, not by the government. Shiretoko was successfully designated as WH in 2005, and the International Association for the Study of the Commons selected this episode as one of the six impact stories in the world in 2010. In Yakushima BR/WH, the number of eco-tourists is so large that natural vegetation is damaged. The Government tried to control the number of tourists, but the municipality assembly failed to build the consensus. When Aya BR was nominated in 2012, the government did not support the nomination document. Now UNESCO fully respects Aya BR as a typical case of bottom-up management by local stakeholders.

O3 - Ancient human agricultural practices can promote activities of contemporary non-human soil ecosystem engineers

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Some South American lowland environments bear impressive legacies of pre-Columbian engineering activities: vestiges of agricultural raised fields that have persisted since their abandonment centuries or millennia ago. We aimed to test the hypothesis that ancient raised fields were — re-engineered by non-human soil organisms, leading to their maintenance against erosion. In a raised-field landscape in a seasonally flooded savanna, we characterized the distribution of soil macroinvertebrates (ants, termites, earthworms) and plant roots between ancient raised fields (in this site, circular mounds) and inter-mound areas and between dry and wet seasons, and quantified the influence of these organisms on soil physical properties and texture. Social insect colonies were highly concentrated in mound soils; their density and species richness were maintained across seasons. Biomass of plant roots was higher in mounds than in inter-mound areas. Adult earthworms were inactive in deep soil layers during the dry season, becoming active at the surface of mounds during the wet season. Combined engineering activities of these organisms in the soil of ancient raised fields led to the accumulation of stable macroaggregates and pores, which should reduce the redistribution of fine soil particles between mounds and inter mounds caused by erosion. Since their abandonment, and perhaps before, raised fields have attracted a diverse and abundant community 50 of soil engineers that enhance the stability of mound soils, allowing their maintenance against erosion.

O4 - Land-use intensity in semi-natural grasslands indirectly affects arthropod diversity through changes in resource diversity or abundance

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Land-use intensification is one of the major drivers for biodiversity loss in many ecosystems. In semi-natural grasslands cutting, grazing and fertilization have been shown to affect the diversity of plants and arthropods but the interactions between these drivers and the chain of effects are little known. In this study we tested whether increased land-use intensity affects the diversity of higher trophic levels (herbivores & predators) through changes in resource (plant & herbivore) diversity or biomass. Two models were set up and compared: A) The 'Resource Heterogeneity Hypothesis' (RHH) predicts that more diverse resources provide more niches for species at higher trophic levels. B) The 'More Individuals Hypothesis' (MIH) predicts that species richness of consumers increases when resource levels are higher. The two hypotheses were tested using structural equation modeling based on plant and arthropod communities in three regions in Germany and for two years. We found positive effects of land-use intensity on plant biomass but negative effects on the diversity of plants and arthropods. For herbivores, the results were consistent with the RHH as we found significant effects on their diversity through changes in plant diversity and no evidence for effects via plant biomass. However, predators were more strongly affected by changes in herbivore biomass than by herbivore diversity. Hence, effects of intensive land-use on predators followed the MIH. These results were overall consistent in all three studied regions and over years. We conclude that higher trophic levels in semi-natural grasslands are generally indirectly affected by land-use intensity but that effects are mediated either by resource diversity or resource depending on the trophic guild. Our study contributes to the understanding of management effects in cultural landscapes which is crucial for the development of sustainable practices.

O5 - Influence of rural land use on plant species composition in the Valdivian coastal range

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The evergreen rainforest in the Valdivian coastal range (VCR) lies within a global biodiversity hotspot of threatened outstanding biodiversity and endemic richness. High rates forest destruction and conversion along with a conservation policy, that established protected areas in remote rather than in biologically valuable areas, has restricted natural forest to extreme sites or rural areas. Rural areas in the plantation-dominated landscape comprise a mosaic of different vegetation types (VTs). The possibilities that this vegetation mosaic may offer as a refugee for threatened species, for the restoration of forest functions and services or the representation of a diverse cultural landscape with unique plant and animal communities, has become important in the recent debate about biodiversity loss and forest degradation on a national and a global scale. Yet the ecosystems that comprise the vegetation mosaic are poorly understood. On a regional scale the influence of land use on floristic composition was studied. VTs were classified and related to environmental variables and variables that measure land use intensity. Variables for livestock grazing and browsing and variables measuring timber extraction explained the differences in floristic composition between the VTs. Effects of single variables and interacting effects were tested. VTs could be assigned to succession and degradation processes. With our study we are doing an initial step towards an understanding that is needed for integrative conservation and management activities in one of the most valuable but less understood ecosystems of the world.

O6 - Responses of fungal communities to agricultural management intensity

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There is great scientific and societal interest in the ecology and functioning of the immense diversity of micro-organisms associated with plant roots. This extends to agricultural systems, where communities of belowground fungi are a largely unknown but potentially important driver of plant productivity and ecosystem services, and display a considerably high diversity. Through sustainable agricultural practices such as organic farming we may be able to influence functions performed by plant-root associated fungi, but we currently lack basic information on the diversity and identity of plant associated fungi in agriculture.

In a set of complementary studies we have sampled organically and conventionally managed fields throughout the Netherlands and Switzerland, and analysed them using molecular tools, asking the following questions: 1) how does organic farming influence arbuscular mycorrhizal community (AMF) composition and richness, compared to conventional farming practices and (semi) natural grasslands? 2) how do AMF communities found in roots and soil within agricultural fields respond to oil-environment, crop and management practices? And 3) how do all fungi found in roots of agricultural crops change with time (2 up to 20 years) since conversion to organic management?

We found that AMF richness is higher under organic than under conventional farming, but not as high as in natural grasslands. However, their communities were more similar to the latter than those found in conventional farming systems. Communities found in soils responded most strongly to management, and their richness was significantly affected by soil phosphorus levels, where high soil P reduced AMF colonization and richness. However, for other root inhabiting fungi there was no strong relationship to organic farming; these were predominantly structured by environmental factors including soil pH and weed diversity.

We conclude that fungi in agricultural systems can be significantly influenced by sustainable management practices, opening the opportunity to enhance sustainability and ecosystem service provision potential of agricultural landscapes.

O7 - Assessing the role of infield ponds and temporary wetlands as stepping-stones conserving plant diversity in agricultural landscapes

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Ephemeral and perennial ponds sized smaller than one hectare are typical landscape elements in north-eastern Germany and other globally widespread landscapes of glacial origin. Within the study area, agricultural land use is mainly intensive. However, infield ponds may provide semi-natural habitats for wetland and aquatic vascular plants and arable wild plants. The occurrence and distribution of species through a 'matrix' of managed fields is expected to differ considering habitat requirements as well as species' persistence and dispersal traits. Additionally, we assume that the topography of infield ponds (i.e. flat-sloped ploughable patches as potentially less permanent sites vs. steep-sloped ones) differ in their conservation value for wetland plants..

The main question was whether flat-sloped (less persistent) sites are able to serve as stepping stones to bridge dispersal distances between ponds. Within our observational study, we expected species richness to be related to patch area, slope and connectivity. Species composition should not differ between slope-classified sites if the flat ones serve as overall stepping stones. When species composition differs, average species persistence traits were expected to differ between pond persistence classes. We identified potential infield ponds via satellite images. On a subset of 46 andomly chosen patches, the presence of vascular plant species and site characteristics were recorded. Analysis was performed using multivariate statistical methods.

Species richness was positively related to the total area of the infield ponds for flat sites only. However, steep patches comprised more species than flat ones. Species composition differed between the slope-classified sites, indicating that the 'stepping stone function' might be species-specific. The average seed longevity of species and the proportion of non-perennial species was higher on patches that are potentially less permanent (flat) compared to more permanent (steep) ones. Even if the studied infield ponds might not harbour strictly endangered species, the protection of both pond types can increase the overall plant diversity within the intensively managed landscape.

O8 - Can short-rotation coppice strips improve biodiversity in agrarian landscapes?

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Short rotation coppices (SRC) provide new options for serving elements of extensive habitat use to the coenoses of agricultural dominated land. If SRC fulfill the expectations to enhance biodiversity in practice was the objective of the research project ELKE. We investigated the habitat effects of short-rotation coppice strips (SRCs) on plant, arthropod and bird communities to determine the role of SRCs in a landscape context. The habitat effects of SRCs were compared to various agrarian and semi-natural reference biotopes to analyse the added value provided by SRCs within the landscape. We compared the habitat quality of SRCs with that of agricultural land and analysed the interactions between SRCs and adjacent cultivated land to assess the potential of SRCs to improve habitat availability in agricultural landscapes. We also investigated the effects of fuel-wood strips on nature-conservation targets and their contributions to habitat connectivity and ecosystem services. We found that SRCs exhibited certain unique habitat conditions that distinguished their biotic communities from those of all other biotopes within the agrarian landscape. The crop stand architecture was highly dynamic, making the SRCs suitable for a mixture of species typical of agricultural fields or grasslands, hedgerows, ruderal plots and forests and resulting in high species richness. With increasing shading by trees, the densities of forest arthropods and bird species that require wood structures increased. Herbaceous ground vegetation developed toward the grassland or field margin vegetation, a vegetation type which is really scarce in many agricultural landscapes in Germany. We conclude that short-rotation coppice strips contribute little to traditional conservation targets, such as rare-species conservation, but they have substantial effects on habitat connectivity and ecosystem services.

O9 - The habitat suitability of short rotation coppices for forest ground beetles (Col.: Carabidae) and spiders (Arach.: Araneae)

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Short rotation coppices (src's) are grown in the younger past for alternative energy production. These agroforestry systems consist of fast growing trees which are cultivated within conventional farmed arable fields. The aim of our study was to test whether these short rotation coppices are convenient habitats for ground beetles and epigeic spiders that are characteristic for forest habitats. We hypothesized that the proportion of forest species and their number of individuals will increase with the standing time of the src's. A small number of forest species will endure the harvest, and forest species will increase again, with increasing growth of the src's (sawtooth hypothesis). We also assumed that changes of the vegetation structure along with altering microclimate are the most important factors that affect the composition of ecological groups over time. The study area was situated near the village Allendorf, Hesse, Germany. The investigation was performed from April to October 2011 and 2012 on four cottonwood src's (aged one to four yrs.) and six reference plots (a mature forest, an isolated grove, a fallow, a hay meadow, a field of winter wheat, and a headland). Ground beetles and epigeic spiders were caught with five pitfalls at each plot. In parallel, the vegetation structure (height and coverage) was surveyed at ten 1 m^2 squares. Additionally, the microclimate (soil temperature and relative humidity) was recorded with data logger at each plot. We found that the proportion of the number of individuals of forest species significantly increased with increasing standing time of the src's whilst the proportion of the individuals of species that are characteristic for arable fields and other open habitat types decreased, simultaneously. A small proportion of individuals of forest species remained after harvesting in the discharged field. The increasing complexity of the vegetation structure together with decreasing temperature and increasing relative humidity at the older src's are the most influencing factors for the increasing proportions of individuals of forest species.

O10 - Analytical methodology for distributions of organisms in cultural landscapes using citizen-based observations

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Utilization of citizen-based observations has become increasingly of interest to researchers, administrators, and stakeholders for purpose of biodiversity conservation. These datasets often consist of information on species, abundances, and years and locations of collections. Regardless of their benefits for large quantity of datasets across time and space, its application to the real world management issues faces difficulties against biases toward habitats and species sampled. In this study, we aimed at utilizing citizen-based observations available in Wetterau district in state of Hesse in order to predict probability of occurrence of habitat-specific organisms in relation to surrounding environment. Through data mining processes of inspecting data quality such as accuracy, abundances, and distributions of observations, patterns and trends are identified and evaluated in terms of distributions of species and habitats. Based on the results of data mining in combination with conditional probability, we suggest analytical methodology derived from citizen science and discuss biodiversity conservation in cultural landscapes.

O11 - Using Dynamic Bayesian Networks to understand cause-effect relationships in the cultural landscape of the Wetterau, state of Hesse, Germany

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Cultural landscapes are fragile landscapes, whose composition intensively depends on the functioning interplay of the landscape matrix, biodiversity and human interplays. Current challenges, like land use change, land cover change, intensification of agriculture, land abandonment, invasive species and global change, set enormous pressure for adaptation on these intricate landscapes. Therefore, a pre-condition for conserving biodiversity is the understanding, how biodiversity pattern and landscape processes are intertwined in the cultural landscapes. Often, the understanding process is complicated by the fact that the data quality of the used proxies does not necessarily meet desired intensities. When relying on data-hungry routines for analyzing the data, setting-up cause-effect networks can be quite a challenge. Then, alternative methods can help gaining insights.

In the cultural landscape of the Wetterau, located in the federal state of Hesse, Germany, we are dealing with many of the above mentioned challenges. Findings on local biodiversity qualities from citizen-related observations, that are used as digitized data bases for biotic and abiotic sources, are integral part for the understanding process on the landscape level, though the spatially heterogeneous distribution of the supplied information sets clear limits to the analysis. Therefore, we constructed probabilistic cause-effect relationships of the observable and latent quantities: Dynamic Bayesian networks (DBN) were used for the understanding of the spatial distribution of the biodiversity variables and their known and hypothezised conditional dependencies in the Wetterau landscape. These networks helped us to improve our understanding of (1) the general relationships on biodiversity distribution in the cultural landscape, as well as (2) how nature conservation relevant taxa, like specific dragonflies, damselflies and bird species, do interrelate with the heterogeneous landscape matrix, when certain *a priori* conditions are met. Finally, these implications for the sustainable management of cultural landscapes are intensively discussed.

O12 - Regeneration dynamics of woodlands in southern Angola after slash and burn agriculture

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The open woodlands of south east Angola, shaped by seasonal droughts, periodical fires and nutrient poor Kalahari sands, seem to be a pristine landscape. However, subsistence agriculture influenced the landscape since more than thousand years mainly via slash and burn agriculture, wood cutting and cattle farming. Due to low soil fertility yields decrease quickly and shifting cultivation is common practice among local farmers resulting in a high demand for space. In order to find suitable places for new fields (e.g. denser woodlands) people accept long walking distances. As Angola is currently undergoing a rapid socio-economic transformation after almost three decades of civil war, the demand for agricultural land is even increasing. Hence, understanding how the ecosystem regenerates after agricultural use is crucial.

The aim of this study is to investigate (1) the biophysical determinants for the existence of denser woodland patches in an open landscape matrix; (2) why these woodland patches are more productive and preferred for agriculture; (3) if regeneration of fields after abandonment is influenced by different land-use intensities.

The study area lies in the hinterland of the Okavango River. Open woodlands, denser woodland patches and three types of fallows, used over different time spans, were investigated. The fallow history was assessed via Landsat time series. On 20x50 m plots species diversity was measured as well as functional diversity based on functional traits, woody biomass, canopy structure and nutrient status of soils.

Preliminary results show that the denser woodlands (preferred for agriculture) exhibit a completely different species composition compared to the surrounding open woodlands, have a higher cover of woody understorey and do not burn regularly. Further results will be presented regarding the general usage of ecosystem services in relation to population growth and the upcoming change of traditional land-use practices.

O13 - Biased dispersal of larvae of *Margaritifera laevis* by its host fish

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Local aggregations of unionoids (mussel beds), which correspond to subpopulations constituting a riverine metapopulation, are presumed to be linked by host fish dispersal during a parasitic larval period (glochidium). We examined movement patterns of *Oncorhynchus masou masou*, the obligate host fish for the freshwater pearl mussel *Margaritifera laevis*, during the mussel's parasitic period to determine the dispersal potential of glochidia via host fish in the Shubuto River system, Hokkaido, Japan. We conducted mark–recapture in a 650-m river section to describe the displacement distance and directionality of host fish movement and fyke net sampling to quantify the number of host fish moving from stem rivers (glochidia sources) to tributaries (thermal refugia). In the mark–recapture study, the movement of *O. m. masou* carrying glochidia ranged from –50 m (downstream) to 500 m (upstream) with a mean of 27.5 m and upstream bias in the study section. In the fyke net study, movement from stem rivers to tributaries was strongly affected by differences in water temperature between each tributary and its adjacent stem river. More individuals, most of which were infected by glochidia (ca. 100%), moved to cooler tributaries, where high glochidial and post-parasitic juvenile survival would be expected. These results suggest that the dispersal of glochidia via host fish is important for upstream movement and that glochidia were effectively transported from stems to cooler tributaries during a period of high water temperature. Our findings provide a first step toward understanding the metapopulation dynamics of *M. laevis*.

O14 - Analysis of pollen foraged by Japanese honeybee colony from a SATOYAMA landscape toward evaluation of ecosystem services

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Japanese honeybee (*Apis cerana japonica*) is possible to contribute to a number of ecosystem services including pollination of wild and crop plants and honey production in typical Japanese cultural landscape, SATOYAMA, which is a habitat mosaic with deciduous forests as a major component. In order to obtain basic information for evaluating the ecosystem services mediated by Japanese honeybees, plant species the bees forage were studied in a SATOYAMA area by using two different techniques: a periodical route-census survey of flower visitation and analysis of pollen collected at the entrances of breeding colony nests using a special type of pollen traps.In spring season, which is the major flowering season of trees of SAOYAMA forests, more than a double

number of plant species foraged were identified by the pollen analysis than by the flower visitation census, which missed species flowering above high canopies such as trees and vines. Difference of foraged flora between two methods was much smaller in summer or autumn seasons, when pollen of crop or herbaceous flowers was dominantly foraged.

Based on such colony-based pollen-analysis data, we can quantitatively identify plant species, landscape components and spatial ranges individual bee colony forage and thus potentially pollinate, which may contribute to the spatial ecological evaluation of ecosystem services Japanese honey bees can provide.

O15 - Biological control of aphids by natural enemies: Effects of predator specialization, host plant and climate

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Aphids are among the most severe invertebrate pests of crops and cause high economic losses. The control of aphids by natural enemies is an essential ecosystem service with high relevance to sustainable management strategies in agricultural plant production and horticulture. However, the current knowledge on the effectiveness of specialist and generalist predators in aphid control with respect to host plants and climatic conditions has not yet been summarized in a meta-analytical approach. Quantitative data on the effectiveness of natural enemies in aphid control was yielded from scientific literature that compares aphid population size in the presence of natural enemies to population size in the absence of natural enemies, e.g. in predator exclusion experiments. Effects of natural enemies on aphid populations were strongest in assemblages that included specialist predators, either alone or with generalist predators, but were weaker on aphid populations feeding on legumes compared with aphids feeding on grasses or herbs. In addition, according to all field studies from the temperate zone the effectiveness of natural enemies in aphid control was related to climatic conditions, particularly high seasonality in precipitation and temperature (e.g. due to extreme weather events) promoted the effectiveness of biocontrol. Our meta-analysis indicates that the control of aphids by assemblages of natural enemies that include specialist predators is most promising in grass and herb cultures (e.g. wheat fields, herbage gardens or meadows), whereas it is less suited for legumes. Facing climate change, the role of natural enemies in aphid control may become more prominent when developing management strategies in the future.

O16 - Ecosystem services of non-crop vegetation in agricultural landscapes - the control of crop herbivory

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Plant species of non-crop structures such as herbaceous margin strips, hedgerows, forest fragments or wetlands provide important habitat functions for several natural enemies of crop herbivores. Several studies have demonstrated that the density of such structures in agricultural landscapes is positively correlated to herbivore regulation but the role of plant species composition is not well understood so far. We used a correlative approach (1) to test the relation between spontaneous field margin vegetation and infestation of crop plants, (2) to compare the influence of plant species composition and diversity with that of landscape structure and (3) to identify plant functional traits that favour natural enemies and reduce crop herbivory.
Using Brassicaceae crops as a model system, we planted ten *Brassica oleracea* (broccoli) seedlings into the margins of each of 24 fields in the French department Maine-et-Loire between Angers and Saumur. The study was repeated in two consecutive years resulting in a total of 48 fields. We analysed the density of herbivores (aphids, caterpillars, cabbage fly eggs, flea beetles) and natural enemies (parasitic wasps (parasitism), ladybirds, lacewings) on the crop plants, the leaf damage and the cover of all vascular plants at a distance of 3 m from the edge of the broccoli plantation (66 m²). We also recorded the proportion of flowering plants in each species. Landscape structure was analysed within a radius of 500 m.

We obtained significant correlations between vegetation (overall diversity, functional groups), crop herbivory (density, damage) and natural enemies (density, herbivore parasitism). In particular, the diversity and abundance of entomophilous plant species explained a large proportion of variance in herbivory. Models combining landscape structure and vegetation as explanatory variables revealed an additional influence of landscape at a larger scale but correlations with vegetation parameters remained significant. The results suggest that the floristic composition of adjacent field margin vegetation has a significant influence on crop herbivory and that the approach allows to identify plant species or functional groups that may improve ecosystem services.

O17 - Economic valuation of access to natural resources around three South Caucasian National Parks

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Because of its exceptional conservation value, the German Federal Ministry for Economic Cooperation and Development (BMZ) initiated a multi-year program on "transboundary" national parks (NP) in the South Caucasus (Armenia/AR, Georgia/GE, Azerbaijan/AZ). Sheep and cattle herding on high altitude summer pastures is one of the most important income sources pressuring NPs and their buffer zones. In an interdisciplinary project on integrated conservation planning in the region, we conducted two twinned, transboundary case studies (Lake Arpi/AR-Javakheti/GE and Zaqatala/AZ-Lagodekhi/GE). Here we report on small famer preferences in Lake Arpi, Javakheti and Lagodekhi for access to natural resources in and around the NPs as well as for training measures for income alternatives. Following qualitative interviews (n=31) and a quantitative pilot study (n=120) a choice experiment (CE) was administered (n=3*100; clustered random sample). The CE was overall highly significant (P(chi², 9 df)<0.0001).

Regularly, households are allowed to collect plants and fuel wood for home consumption. Preferences for additional opportunities for commercial exploitation of these non-timber resources could not be found (P=0.133), but a loss of current access is of major concern. To compensate for a potential loss of access for home consumption (willingness-to-accept compensation, WTA), respondents require, on average, a minimum payment of 12% of their monthly income (P=0.001). For each 1% restriction of summer pasture area, WTA is 0.7% (P<0.0001). Training measures of bee-keeping (P=0.001), cheese production (P<0.0001), and tour guiding (P<0.0028) are well-appreciated (positive willingness-to-pay, WTP); there are pronounced regional differences, though.

In view of the highly precarious economic situation of the population of the case study areas, we suggest that further restrictions of local land use (non-timer resources, summer pastures) in favor of conservation concerns need to account for the substantial local economic losses associated. Buffer zone management should focus on regionally differentiated training measures that are able to increase local incomes.

O18 - How can we conserve Satoyama landscapes in Japan under the situation of rapid depopulation and the collapse of agriculture?

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Satoyama is a Japanese traditional rural landscape formed by sustainable use of natural resources. The national biodiversity strategy of Japan, which is revised in the end of September 2012, pointed out biodiversity loss in Satoyama landscapes as one of major crises. The richness of biodiversity has been caused by artificial disturbance related to agricultural activities. However, the area of non-managed agricultural land in Satoyama landscapes has rapidly increased due to aging problem of farmers and depopulation in rural areas. The Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) has reported that the total area of arable land was 45,930 km^2 in 2010 and 400 km^2 (8.1 % of arable land) was abandoned. The area of abandoned field in 2010 increased at triple in 1985.

In late February 2011, a Longterm Perspective Committee under the National Land Council of Japanese Ministry of Land. Infrastructure, Transport and Tourism (MLIT) announced its midterm report on the outlook of Japan for the year 2050. It is estimated that if trends continue at their current pace about 20% of the currently inhabited land will lose all its population by 2050, and an additional 20% or so of Japan's land will have fewer than 10 residents per square kilometers.

The disaster on 11th March 2011 should drive depopulation and aging in damaged areas further. The Japanese government has decided to become a negotiating partner of Trans-Pacific Partnership (TPP), which aims to further liberalize the economies of the Asia-Pacific region. MAFF estimates that if Japan opens its agricultural market under TPP production of agriculture, forestry and fisheries in Japan will go down by 3 trillion yen and rice production will become two-thirds. It should cause massive abandonment of rice paddy fields in a steep slop area, which have maintained species richness. We have to consider alternative methods to conserve biodiversity in Satoyama landscapes.

O19 - Overview of land-use pattern of Japan with biodiversity-conscious land-use classification and Satoyama Index

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For overviewing Japan from the viewpoint of biodiversity of *satoyama* (traditional heterogeneous agricultural landscape), we classified and mapped land uses in the national land into “wilderness land use”, “rural land use”, “plantation”, and “urban land use”, using a high resolution (50m-grid) land-use map. We also mapped modified *satoyama* index (M-SI), which is defined as Simpson’s diversity index of land-use types within a 6-km square weighted by proportion of agricultural land uses, for every rural land-use cell.

As result, national and quasi-national parks were shown to include not only the wilderness land-use cells at higher rates than outside, but also rural land-use cells with high M-SI (≥ 0.5) significantly more than expected.The present world natural heritage sites in Japan, except for Ogasawara Islands, were shown to include relatively few rural land-use cells, while cells with high M-SI were shown to widely distribute in Amami Islands, a part of a candidate area for new world natural heritage sites.

From these results, we concluded that conservation managements for *satoyama* in national parks can highly contribute to biodiversity conservation in Japan.

O20 - Concretion of agri-environmental goals

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In 2008, the Federal Office for Environment FOEN and the Federal Office for agriculture formulated environmental targets for agriculture. Quantification and regionalization are essential for the further fleshing out of these targets in the field of “Species and Habitats”. The presentation will show quantitative and qualitative targets for the various agricultural zones and regions which were defined according to the potential distribution of target species. To this end in a first step quality criteria were defined for areas and regions – henceforth be called “Agriculture-related Environmental Objectives Quality” or AEO Quality for short. In a second step we estimated the size of the currently available share of AEO Quality areas in the various agricultural zones and five main regions. In a further step target shares were proposed. These are based on case studies of networking projects and various already published studies. Whereas sufficient AEO Quality land is still available in the higher mountain zones and the summer pasturing area, there is a shortfall of AEO-quality land in the plain region and the low mountain zones. With the currently identified ecological compensation areas, the quantitative target shares falls only slightly short of being achieved. In order to remedy the qualitative shortcomings and achieve the proposed target shares, a tripling of the share of AEO Quality areas in these agricultural zones is required. – especially for ecological compensation in arable farming. Moreover, in order to promote species diversity, specific support measures for target species and high priority indicator species are required in all regions. Key aspects of the habitats to be preserved and promoted are also given for 24 subregions. Databases and report in German language see www-uzl-arten.ch, soon available in French too.

O21 - A Landscape generator and its exemplary application as tool for integrated regional environmental impact assessment of energy landscapes

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Bioenergy production from first generation energy crops has been increased strongly during the last years in several regions worldwide and has led to increased land use change at a landscape scale.

Such large scale application may cause land-use conflicts and loss of biodiversity, especially if land use change yields monodominant stands.

There is urgent need to develop sustainable land use options for biomass use for bioenergy purposes and to assess their environmental impacts at a landscape scale beyond GHG emissions, including impacts on biodiversity.

We present a new landscape generator model with an application to Central European landscapes. The landscape generator is capable of varying spatial structures of model-landscapes systematically, e.g. landscape configuration and composition, and relative distribution of cropping systems. First it produces a naturally looking landscape unit by distributing forest and agricultural area in typical settings for central Europe. In a second step, it distributes fields of different sizes and crops over the agricultural area, thus translating non spatial energy demand scenarios into spatial energy landscapes.

We present an exemplary application focusing on scenarios studying i) the potential impact of different sized biogas plants, ii) the potential impact reduction of the proposed percentage of set-aside areas for the CAP, and finally iii) the impact reduction of structurally rich landscapes on farmland and forests bird species, and on pollinators. The applied model is a spatially explicit ecological model and uses a multi-species evaluation approach. It combines stylized preferences of selected bird and bee species, including crop suitability for nesting and foraging and spatial heterogeneity.

The generated model-landscapes, can be investigated consistently by several collaborating projects with specific questions related to the bioenergy impact on the environment and will be further developed to include more spatial elements of the energy system and to assess their environmental impacts. The use of the same model-landscapes for all collaborating projects ensures a consistent multi-criterial impact analysis.

O22 - Ecological restoration as a team project of multiple stakeholders: a case study in Mikata Five Lakes (Fukui, Japan)

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We have been conducting an integrative, multifaceted study of a lake ecosystem using ecological and social scientific approaches in order to provide a basis for “nature restoration”, a legal framework for biodiversity conservation in Japan. The studied system is Mikata Five Lakes located in a central part of Japan, which harbours distinguished biodiversity in, for example, fish fauna. The recent status of biodiversity of this lake, however, has been declining and thus the ecological restoration is in demand. We have examined what environmental conditions need to be restored primarily in this system. We also tested some restoration measures and evaluated the effectiveness. Through these researches, we provided the start of adaptive measures for the ecological restoration, and the Nature Restoration Committee was established in May, 2011 with a significant involvement of researchers. I will talk about the progress of our project for the last three or so years and discuss what we can contribute to the local community.

O23 - Land use, biodiversity and ecosystem functioning: the need for quantitative approaches

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Land-use is known to strongly affect biodiversity and ecosystem functioning, and quantifying this effect is a major aim of ecological research. While the dependent variable in such studies is often measured rather carefully, e.g. the species richness of a particular taxon, the independent variable is often defined rather loosely, in particular in the case of land use intensification which implies a gradient of increasing management effort. While many studies report a decrease in biodiversity with increasing land use intensity, the particular management actions that underlie such a decline are mostly unclear. One of the reasons is that studies often contrast extremes, or collapse various management regimes into discrete land use intensity categories. Another reason is that there are many management components which are not studied separately. We review and categorize quantitative descriptors of land use intensity and develop a conceptual framework for analyzing the relationship between land use and biodiversity change.

Land use intensity can be described either by the output obtained from a unit of land in terms of natural or monetary yield, or by the input necessary to manage the unit of land in terms of human effort, materials, chemicals, energy, etc. The output-related approach is likely to be more appropriate when comparing a single crop managed in different ways, while the input-related approach is superior in case of several different input factors, e.g. fertilization or pesticide applications. There are a variety of approaches to take management components into account, ranging from using ordinal gradients of land use intensity to analyzing single management components separately. There are also differences between different types of ecosystems. We present several recently developed measures of land use intensity for both agricultural and forest systems and discuss their advantages and disadvantages in the light of our classification.

P1 - Impact of differences in shade tree diversity in cacao agroforestry systems on woody biomass and productivity

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Cacao (*Theobroma cacao*) is one of the most frequent cash crops cultivated in the tropics. There, large areas of natural forest are replaced by agroforestry systems, most of them managed as monocultures. The presence of shade trees is commonly thought to negatively affect growth and yield of cacao trees due to competitive use of water, nutrients and light. Therefore, cacao monocultures are assumed to be of greater economic value than agroforestry. However, there is still little information about systematic differences between different cacao cultivation systems and only weak information exist with respect to belowground biomass, productivity and other rooting patterns.

We studied different cacao cultivation systems in Central Sulawesi, Indonesia, with respect to differences in above- and belowground structure, biomass, and productivity. We compared plantations of i) cacao monocultures, ii) cacao admixed with the nitrogen fixing *Gliricidia sepium* shade trees, and iii) cacao growing together with various shade tree species.

In contrast to the general assumptions, we did not find significant negative ecological effects of shading. Differences in the vertical rooting pattern of the crop and shade tree species in the three different cultivation systems suggested partitioning of water uptake.

Cacao bean yield and fine root production did not differ significantly between the different cultivation types. However, stem growth in all tree species was influenced by the different species composition. Cacao trees cultivated together with *Gliricidia* shade trees had higher stem growth than in the other two cultivation systems.

Overall, these results show that the cacao cultivation together with shade trees does not reveal significant negative economical (crop yield) or ecological effects, but rather higher above- and belowground net primary production.

P2 - Movements of ground beetles (Col.: Carabidae) and spiders (Arach.: Araneae) between short rotation coppices (src's) and adjacent biotopes

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In the recent past, short rotation coppices (src’s) are cultivated within arable fields for energy production as well as to establish more diverse structural elements within the otherwise poorly structured arable landscape. Our investigations were performed within a src plantation that was composed of fast growing cottonwood hybrids cultivated within conventionally farmed arable fields in the low mountain range of Hesse/ Germany. The plantation was harvested in a rotation mode within four years in a way that areas of different ages were adjoining. The arable landscape was surrounded by hay meadows, deciduous forests, and small woody and fallow patches. From investigations of ground beetles and epigeal spiders with conventional ground traps that were performed in src's of ages between one and four years in two consecutive years (2011 and 2012) we were able to demonstrate that with up growing trees the number of individuals of forest species were increasing significantly. In the present study we hypothesised that forest species will leave a freshly harvested src and move towards an adjacent src advanced in years. Contrawise, species with a preference to open habitats will move from adjacent treeless habitat types into the src, recently harvested.

To test our hypothesis, we placed five pairs of directional ground traps near the edges of the harvested src and a fallow, a field of winter wheat, and another src, three years of age. The remaining pairs were operated between src's that were three and two years old and one pair between a field of winter wheat and the src with three years of age.

We found that ground beetles with preference to open habitats, species of arable fields in the first place, performed directional movements between the harvested src, the fallow land, the field of winter wheat, and the three year's old src. Ground beetles with preference to forests only leave the freshly harvested src if an older one was directly bordering. Otherwise they stayed in the harvested src. Epigeal spiders performed directional movements between younger and older src's. Spider species that prefer arable fields showed movements from older to younger src's.

P3 - Earthworm casts as a monitoring tool to assess earthworm density in field

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Methods mainly used for earthworm field monitoring are time-consuming, costly and require expert knowledge. These disadvantages might be sometimes the reason for excluding earthworms from large biodiversity surveys. Furthermore, farmers and agricultural consultants are often interested in earthworm density in fields as indicators for several ecosystem services. However, they avoid the effort in doing such a survey because of other obligations and constraints. Considering this, it seems to be of much interest to develop easily realizable methods for earthworm monitoring, which can be used by non-experts and are not that time-consuming. Fründ (2010) has proposed to scan the soil surface for casts, middens and burrow openings of earthworms as a first indicator for assessing soil quality. This approach is picked up in the present study as basis for developing an indicator of earthworm density in arable fields for non-experts.

Along two transects (10x0.4 m) per field earthworm-casts were counted on the soil surface. Thereafter, earthworms were sampled using Allyl isothiocyanate coupled with hand-sorting at three locations per transect (at 1-1.5 m, 4.75-5.25 m and 8.5-9 m). Here, pits of 50x50x10 cm were excavated and the soil searched for earthworms. Into these pits, the Allyl isothiocyanate solution was poured in two portions of 5 L to expel earthworms from deeper soil layers. In laboratory, earthworm biomass per transect was measured. Earthworms were identified to species level.

First pre-tests of the method described above were carried out on four fields, which are part of a study on the influence of reduced soil tillage on soil biodiversity. Positive correlations were found between surface casts and number of individuals (r^2=0.46), as well as between casts and biomass of earthworms (r^2=0.47). Positive correlation between number of individuals and casts is given for anecic (r^2=0.37), as well as for endogeic (r^2=0.42) species. Furthermore, significant differences for number of individuals and biomass could be shown between the different tillage systems.

First results indicate soil surface scanning for casts as a reliable tool for assessing earthworm density in arable fields.

Fründ, H.-C. (2010). Verfahrensvorschlag bodenbiologischer Standortindikation. Boden und Standortqualität - Bioindikation mit Regenwürmern. Fachhochschule Osnabrück, DBG, BVB.

P4 - Polycultures increase abundance of cavity-nesting Hymenoptera and parasitation rate in simple, but not complex tropical rice landscapes

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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 to benefit humans. The placement of trap nests can provide insights into abundance, trophic interactions and habitat requirements of Hymenoptera on a local and a landscape scale. This information is needed to counteract threads by an increasing intensification of agricultural practices in rice-dominated landscapes.

We selected eight study sites in Luzon, Philippines, located in agricultural landscapes representing different levels of habitat heterogeneity: mainly forest plantations, mainly rice production and mixed landscapes. In each study site trap nests were installed in isolated rice fields, in rice fields adjacent to a polyculture and inside those polycultures (e.g. home gardens, vegetable fields, fruit tree plantations).Nests were collected four times over a period of eight weeks. After collection nests were dissected, the number of brood cells was counted, and the cavity-nesting species and their natural enemies were recorded.

Overall 738 nests were collected containing 1860 brood cells of Eumeninae, Megachilidae and Sphecidae and their natural enemies (Tachinidae, Phoridae, Brachonidae and Calcidoidae).

We found a higher number of cells and an increased parasitism rates inside the polycultures compared to the rice fields, but this difference was only present in landscapes dominated by rice fields and was absent in the forested and mixed landscapes.

The results show that in landscapes dominated by rice production trap-nesting Hymenoptera and their natural enemies can profit from polycultures whereas in forested areas the nest availability might be sufficient.

We conclude that especially in simple and open landscape, polycultures should be promoted to maintain the abundance and complex interactions of species that provide pollination and biological control services.

P5 - Social viability of the biological corridor designated for the Sierra Madre Oriental (San Luis Potosí, Mexico)

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Biological corridors have been developed as a conservation strategy to counteract species loss caused by habitat fragmentation. However, usually, such areas are not under any protection category. Therefore, its establishment has to consider biodiversity conservation and socio-economic aspects, which determine the viability of the corridor. The main objective of the research was to find priority sites for conservation and routes of connectivity for flora and fauna and to evaluate the potential of conserving these routes through a socio-economical analysis. The research was conducted in the Sierra Madre Oriental (San Luis Potosi, Mexico), which has been proposed as a biological corridor but has not been established yet. For the biological assessment, I used secondary data of endemic species of birds, mammals and herpetofauna recorded in the study area to create distribution models; with the overlapping of each species distribution, priority areas for conservation were obtained. For the socio-economical assessment, I did field interviews in different localities and physical features of the landscape (topography, land-use, vegetation cover, rivers, and roads maps), connectivity routes were determined. The resultant connectivity routes are proposed as important areas to focus conservation efforts and economical resources because of their potentiality for contributing positively to nature conservation and for social viability.

P6 - Network structure and political framework related to ecosystem services in districts Vogelsberg and Wetterau (Hesse, Germany)

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Within the JAGUAR-project I analyze on the one hand the different scales of political frameworks, in which ecosystem services are regulated. The scales range from the EU-level to the national level (Germany), over the state level (Hessen) and the district level (Wetterau and Vogelsberg) to the municipality level.

On the other hand I create a database with information e.g. about:

- the different indicators which are using to evaluate ecosystem services
- the attitudes towards ecosystem services

One aim of the JAGUAR-project is the implementation of a sustainable land use management system. To achieve this aim it is necessary to know the network structures within the study regions. Furthermore within the *concept of ecosystem services* ecosystem services represent the benefits human populations derive directly or indirectly from ecosystem functions. From this view the stakeholder analysis is also crucial.

P7 - Analyzing soil- and water related ecosystem services in cultural landscapes

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Among the main effects of human activities on the environment are land use and resulting land cover changes. Such changes impact the capacity of ecosystems to provide vital services for human wellbeing such as fresh water supply, global climate regulation through carbon sequestration or the conservation of soil fertility. To describe these dynamics appropriate indicators and models for their quantification are needed. By linking land use information, abiotic data, land survey and GIS with modelling approaches , ecosystem service supply can be assessed and transferred to different spatial and temporal scales.

In our study of the cultural landscapes in the Wetterau and Vogelsberg region we apply existing soil and hydrological models (such as the Catchment Modelling Framework) for ecosystem functions (hydrology, nitrogen, carbon) in order to quantify storage and fluxes of key components of biogeochemical processes that determine to a large extent both provisioning and regulating ecosystem services.

Session 5 - Emerging topic in ecosystem sciences: Physiological responses of trees and forests to environmental stress

Chair: Henrik Hartmann, Guenter Hoch, Thorsten Grams, Ansgar Kahmen

O1 - Tree responses to environmental stress: 385 million years of evolution face rapid climate change

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Trees have evolved over the last 385 million years and have become a dominating terrestrial life form. Recent observations indicate that trees and forest ecosystems may be particularly sensitive to changes in environmental conditions. Especially extreme events (drought and heat spells) threaten the productivity and survival of forests in many parts of the world. There is an increasing number of studies showing that the extensive vascular system of trees may become dysfunctional during extreme events and that trees may face hydraulic failure and carbon starvation during drought-induced mortality. In this introductory talk, I will give basic information about the observed declines of forest ecosystems. I will highlight how trees are affected by changes in water availability and increased temperature with a brief overview of selected relevant studies from the literature as well as from personal investigations.

O3 - Living with cavitation: Sub-diurnal cycles of xylem cavitation and refilling in pine trees under seasonal drought

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Xylem embolism and cavitation reduce hydraulic conductance and therefore bear major implications for plant functioning and survival. Yet the observed ability of trees to survive high levels of cavitation (percent loss of conductivity, PLC, up to 80%) suggests the existence of an efficient reversal mechanism.

Hourly changes of hydraulic conductivity were studied in branches of mature *Pinus halepensis* trees in a semi-arid forest. Sap flow (SF) and leaf-scale transpiration (T) were measured simultaneously.

During the wet season, T peaked at mid-day, and SF lagged by about 2 hr. But during the dry season T peaked at 9:00 with a minor peak later in the day, while SF lagged by up to 9.5 hours behind the T peak. Xylem cavitation (PLC of 30-40%) developed and reversed twice a day, in the morning and in the afternoon, coinciding with two peaks in stomatal conductance. Consequently, large water deficits (5 kg tree^{-1}) developed, and up to 33% of the daily transpiration flux came from water storage.

Based on these observations, we speculate that leaf conductance response is partly decoupled from changes in PLC, such that moderate cavitation and recovery of xylem conductivity in our extremely dry conditions are routine during daytime.

O4 - Always trouble with the neighbour? Water relations among beech and spruce trees under drought

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Species mixtures in forests, e.g. between Norway spruce (*Picea abies*) and European beech (*Fagus sylvatica*), frequently results in higher productivities than in respective monocultures. According to the stress-gradient hypothesis, these over-yielding effects may be particularly strong under harsh environmental conditions. However, we are far from a sound understanding of mixing effects in forests. This contribution aims at shedding light on facilitative, i.e. positive, interaction between important central European trees species, namely European beech and Norway spruce, under periods of severe drought.

A newly initiated long-term experiment on the drought response of adult forest trees grown in a mixed beech/spruce forest in southern Germany (Kranzberg Forest) is introduced. A novel through-fall exclusion infrastructure with automated shutters that close during periods of rainfall is established in the forest. Six drought plots with 8 - 15 trees each (total area of 900 m^2) are compared with respective trees on control plots. Focus is on the drought response of trees with intra-specific neighbours to trees grown in species mixture.

First results under initial conditions (i.e. in the absence of drought) gave evidence for a better water supply of spruce trees grown in mixture with beech compared to trees grown under mono-specific interactions. Conversely, beech appears to benefit from the mixture with spruce in its nutrient status as indicated by an increased leaf nitrogen concentration compared to beech trees with monospecific interactions.

O5 - On the relation between productivity and hydraulic properties in Mongolian *Larix sibirica* forest-steppe ecotones

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In the Mongolian Altai, forests are representing the southernmost fringe of the Siberian taiga. The region receives little precipitation (c. 100-250 mm yr^{-1}) and is characterized by a subzero annual mean temperature. Forests occur on north-facing slopes and border on steppes in valleys and on south-facing slopes. The forests are strongly dominated by Siberian larch (*Larix sibirica* Ledeb.); the tree line to the steppe has been modified by anthropogenic disturbance. Dendrochronological studies in this area showed that human disturbance (mainly logging) has caused opposing growth responses within the same stand both in the interior and the forest edge. To study how this diverse growth trends may be linked to tree water use, hydraulic conductivity and hydraulic architectural features of roots and branches were compared between forest edge and interior. In addition, *L. sibirica* trees growing in the Mongolian Khangai and in a plantation in the German Ore Mountains with its favorable site condition (more precipitation, soil water content and resource availability) was chosen to compare hydraulic traits and growth performance of *L. sibirica* growing under different environmental conditions. We tested the following hypotheses: (i) *L. sibirica* growing in Ore Mountains show a higher hydraulic conductivity compared to the Mongolian stands; (ii) in Mongolia, hydraulic conductivity is higher in forest edge than in forest interior congruent with a higher productivity; (iii) a higher productivity and thus hydraulic conductivity is achieved by larger and more conductive conduits. As assumed, the highest sapwood area-specific hydraulic conductivity (K_s) in both roots and branches was found in trees growing in the Ore Mountains. In Altai, K_s was higher in branches (but not in roots) from the forest edge than from the forest interior, which was consistent with stem basal area increment, and was accompanied with similar trends observed in wood anatomical traits, i.e. the hydraulically weighted vessel diameter (d_h). We conclude that increasing annual precipitation is directly reflected in an increased hydraulic conductivity achieved by larger conduits causing a higher productivity on tree and stand level.

O6 - High-light acclimation of young afforested beech (*Fagus sylvatica* L.) exacerbates productivity decline under water limitation.

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For Central Europe climate models predict increasing frequency and intensity of summer drought events. Under such perspective conversion of drought susceptible spruce monocultures by underplanting young beech (*Fagus sylvatica* L.) is considered as a silvicultural measure to reduce drought-related risks of forest stand losses in future. Typically, employed beech plants are derived from tree nurseries were light conditions may substantially differ from those at the forest sites. The resulting mismatching light acclimation is likely to affect drought response patterns upon transplantation. In a three-year field experiment, the response of transplanted beech to extreme and repeated summer drought and the dependency of drought response patterns on light exposure was investigated. In autumn 2008, two-year-old beech was planted under a Norway spruce stand primarily opened through winter storm. In the growing seasons of 2009 through 2011, manipulation of precipitation induced a pronounced gradient of water availability. During the three growing seasons, individual drought-stress doses (DSD) and light doses (LD) were calculated for each beech sapling. Plant growth, CO_2-assimilation rate and stomatal conductance were reduced with increasing drought stress, but facilitated by increasing light availability. During the three years of the experiment, decreased drought and shade sensitivity of diameter growth indicated that the plants were progressively acclimating to water and light limitation. Water-use efficiency, root/shoot ratio and rooting depth increased with decreasing water availability. Positive correlations with both DSD and LD were found for the specific fine root length and the proportion of very thin fine roots. Progressively increasing specific leaf area and reduced leaf dark-respiration indicated proceeding low-light acclimation. As we found that inadequate high-light acclimation exacerbates productivity decline at high DSD following transplantation, we recommend light-preconditioning of the beech saplings in the nursery.

O7 - The joint evolution of serotiny and age of first reproduction in Mediterranean pines - eco-evolutionary tipping points under climate change

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The consequences of global climate change as well as their societal and ecological impacts are increasingly well investigated and affect environments in many different ways. For instance, it is predicted that fire frequency in the Mediterranean areas will increase.

Many Mediterranean trees are adapted to and even require fires, as they produce serotinous cones, which depend on fire to open and release seeds. In the Aleppo pine (*Pinus halepensis*), populations exposed to different fire frequencies differ in the degree of serotiny (the proportion of serotinous vs. non-serotinous cones on individual trees). Non-serotinous cones are especially beneficial if fire frequency is low and individuals start to reproduce early.

Using individual-based models parameterized for Spanish *P. halepensis* populations, we investigate the joint evolution of the degree of serotiny and the age of seed maturation under different fire regimes. We examine, under which fire regimes the production of both serotinous and non-serotinous cones is evolutionarily favorable. Additionally, we investigate, how increasing fire frequencies will affect the survival of populations, which are adapted to lower fire frequencies. Thus we try to identify both ecological and evolutionary tipping points.

O8 - The interaction of endophytes and forest trees in changing environments

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Endophytic fungi, which are hosted by living tissues of forest trees, seem to be a common phenomenon. A number of studies and reviews confirm that these colonists mostly live symptomless or that their interaction with the host tree is of symbiotic nature. Nevertheless, the lifestyle of an endophyte (mutualism, commensalism or parasitism) is not always obvious: in a number of cases the endophyte provides the host plant with some ecological advantages – so it is more or less a mutalistic relationship. On the other hand, some apathogenic endophytes may become virulent under certain environmental conditions, dependent on the genotype of the host plant. So, the microorganism may turn into a parasite. Our investigations on Douglas-fir and Rhabdocline needlecast give evidence that *R. pseudotsugae*, which has been described exclusively as an obligatory needle pathogen up to now, may persist symptomless in different types of plant tissues of Douglas-fir. Therefore, an endophytic lifestyle is assumed. It is still unclear whether this lifestyle is part of the infection strategy of the fungus. However, examples of other wood associated fungi lead us to the hypothesis that environmental conditions (e.g. climate conditions or unfavorable stand conditions) seem to trigger the phenomenon of changing from a virulent needle pathogen to a latent apathogenic endophyte which is highly adapted to the host plant, due to a highly effective way of distribution via seeds.

O9 - Oak mortality in a rewetted peatland - adapt or die

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Soil-waterlogging with the subsequent anoxic soil conditions is besides drought one of the major stress factors for trees. Increasing frequencies and intensities of heavy rainfall events as well as an increase in winter precipitation as projected for northern Central-Europe might therefore have severe impact on forest growth on hydric sites. Although pedunculate oak (*Quercus robur* L.) is among the tree species with a relatively high tolerance to soil waterlogging, its potential to adapt to increasing soil waterlogging is limited.The Anklamer Stadtbruch, a partly forested peatland at the Baltic seashore has been drained for several decades but was occasionally flooded. In November

1995 a severe storm-flood permanently damaged the dam. As a consequence, water tables near or above the surface led to area-wide forest dieback. Only at the somewhat higher areas some of the trees, mostly oaks, survived. This well-defined disturbance event offers the unique possibility to study the influence of increasing soil water saturation on oak growth. For our dendroecological study we sampled tree cores from living and dead oaks. Conventional tree-ring analysis was combined with high-resolution X-ray fluorescence analysis of elemental concentrations. Our results show a remarkably growth depression following the flooding event but for some trees also a recovery to "normal" growth rates after some years. Interestingly, although general growth patterns are similar between groups of surviving and dead trees, we found significant differences in mean sensitivity (a measure for year to year ring-width changes) and autocorrelation between the two groups in the decades *before* the flooding event. This may point at individual differences in adaptation potential rather than microsite influences determining survival or death. Elemental concentrations show poor common variations between individuals and interpretation is complicated by the fact that most of the elements show a sharp concentration difference between heart- and sapwood. This heartwood-sapwood border occurs around the year 2000 (in living trees) and obscures potential concentration increases of elements like Manganese, Iron or Chlorine caused by the flooding event.

O10 - Bomb-radiocarbon measurements reveal that several-years-old storage carbon is used regularly for respiration in trees

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Although pulse-labeling studies follow the fate of recent photosynthetic products over days to months, much less is known about the use of carbon (C) that was assimilated more than 1 year previously in trees. Trees have the potential capacity to store C in nonstructural reserves for later use, e.g. when the supply of recent assimilates is insufficient to meet metabolic demands. Comparison of the radiocarbon (^{14}C) signature of CO_2 emitted by trees with the observed rate of decline in atmospheric ^{14}C-CO_2 provides a measure of the time elapsed between fixation by the plant and return to the atmosphere (we refer to this elapsed time here as the "age" of the CO_2), thus allowing detection of older (>1 year-old) C contributing to CO_2 efflux.

We report ^{14}C data measured on CO_2 emitted from live tree stems and roots of a number of tree species from temperate and tropical forest ecosystems. Our data indicate that across all ecosystems and species, the emitted CO_2 originates from sources fixed up to several years previously, suggesting that trees make use of storage C pools on a regular basis. Measuring the radiocarbon signature of CO_2 samples extracted from within the tree stem reveals that the age of CO_2 gets older towards the

center of the stem, with the oldest samples measured so far being fixed between 20-30 years previously. The CO_2 that is emitted into the atmosphere at the stem surface represents a mixture of CO_2 produced at different depths and usually has an average age between 0-6 years. So far, all investigated trees were measured under growing conditions that are not associated with any kind of obvious stress, i.e. there is no reason to assume a severe limitation of current C fixation that would result in a lack of new assimilates. The fact that we found evidence for the use of several-years-old storage carbon under these conditions contradicts the widespread assumption that mobilization of storage C occurs only during periods of C limitation. Still, in future work, we want to include measurements from stressed trees to see whether a reduced supply of new assimilates further increases the mobilization of storage C pools, and thus results in even older CO_2 being emitted to the atmosphere.

O11 - Disscusion

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P1 - European deciduous trees exhibit similar safety margins against damage by spring freezing along elevational gradients

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Minimum temperature is assumed to be an important driver of tree species range limits. We investigated during which period of the year trees are most vulnerable to freezing damage and whether the pressure of freezing events increases with increasing elevation. Particularly, we assessed the course of freezing resistance of buds and leaves from winter to summer at the upper elevational limits of eight deciduous tree species in the Swiss Alps. By reconstructing spring phenology of these species over the last eight decades using a thermal time model, we linked freezing resistance with long-term minimum temperature data along elevational gradients. Counter-intuitively, the pressure of freeze events does not increase with elevation, but deciduous temperate tree species exhibit a constant safety margin (5 to 8.5 K) against damage by spring freeze events along elevational gradients, due to the later flushing at higher elevation. Absolute minimum temperatures in winter and summer are unlikely to critically injure trees. Our study shows that freezing temperatures in spring are the main selective pressure controlling the timing of flushing, leading to a shorter growing season at higher elevation and potentially driving species distribution limits. Such mechanistic knowledge is important to improve predictions of tree species range limits.

P2 - Climate Change and Forestry in Rhineland-Palatinate (Southwest-Germany) - an integrative assessment of regional impacts

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To assess effects, risks and chances climate change can cause in Rhineland-Palatinate and which possible adaptation options can be developed, was the aim of the project ***KlimLandRP*** ("Climate and Landscape Change in Rhineland-Palatinate"). Rhineland-Palatinate is plenty of characteristic forest landscapes as Palatinate-Forest and Hunsrück.

Based on different IPCC-Emission scenarios, different regional climate projections, and two time stages (until 2050 and until 2100), insights about the expected regional impacts of climate change on the Rhineland-Palatinate woodland could be acquired. In general, the methodical approach consists of an empirical and a deductive analysis of the climatic suitability of the main tree species under changing stand conditions, through a GIS-based analysis of Rhineland-Palatinate's forested areas. More specifically, the method is made up of the integration of several approaches (self developed or published). Used approaches are e.g. **bio-climatic envelopes** for the main tree species under different climate parameter combinations, **climatic suitability mapping** for the main tree species, **climate sensitive forest growth simulation** of the most relevant forest types and forest landscapes, **water budget simulation for typical forest sites** as well as diverse case studies on different spatial resolutions. In general, the different results lead to consistent insights: on the one hand in several regions the forestry production risk increases, on the other hand some tree species would be able to profit, e.g. due to the warming tendency in today's cool regions.

The presentation provides an overview of the applied methods, and main results for the several time stages under different IPCC-Emission scenarios are exemplary presented. Furthermore, an **integrative interpretation** of the several results is stated. This study is an example on assessing climate change impacts on the forest land use on a landscape scale.

P3 - Climate and vegetation structure determine plant diversity in *Quercus ilex* woodlands along an aridity and human use gradient in Northern Algeria

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We studied the influence of environmental factors related to climate, soil and vegetation cover on total species richness, species richness of different functional types and species composition of plant communities occurring in *Quercus ilex* woodlands, across a 450-km long transect in Northern Algeria. We sampled vegetation and environmental data at 81 10x10 m^2 plots in five zones representing the largest *Q. ilex* woodlands across the study area, and analyzed them under an *a-priori* hypothesis frame. Changes in plant diversity were mainly influenced by environmental factors related to precipitation and temperature regimes, and by total vegetation cover. In particular, changes in species composition were determined by factors related to the temperature regime through their influence on both, woody and annual herbaceous plant richness, and by factors related to the precipitation regime through their influence on perennial herbaceous plant richness, likely due to the differential tolerances of these functional groups to cold conditions and water stress. Our results emphasize the importance of differences in environmental adaptability of the most important functional types for explaining compositional change (beta diversity) along aridity gradients, and the mediator role of total vegetation cover in relation to the effects of soil conditions on plant diversity.

P4 - New Approaches to monitoring drought stress on the leaf level in European Beech (*Fagus sylvatica*) and Sessile Oak (*Quercus petraea*)

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In our forest ecosystems an increase in the magnitude of drought stress can be lethal. To prevent it in time and to determine the proper course of action for intervention, it is important to have a clear understanding of the way drought stress affects trees and their productivity. In our case that of the main broadleaved tree species of Central Europe, Fagus sylvatica and Quercus petraea.

In greenhouse trials, we looked for ways to quickly and reliably detect drought stress patterns in potted, five to eight year old trees. We subjected them to artificially induced drought stress and then monitored the trees' decline using ZIM turgor pressure sensors while manually recording gas exchange rates. By placing the continuously measuring ZIM-probes at different levels throughout the tree canopy and performing manual LI 6400 measurements on previously marked leaves in immediate proximity to the ZIM leaves, we obtained two datasets for each tree.

Special emphasis was put on the way the manual measurements were performed (resulting in a daily measurement at optimal photosynthetic conditions) and the way the ZIM-data was analyzed (choosing a modification of the classical pre-dawn measurement). We furthermore analyzed obtained data for inter-instrumental difference and differences between different locations throughout the tree.Both instruments monitored the increasing drought stress well, with some variations in accuracy between instruments, depending on environmental conditions (VPD and global radiation) at the point of measurement. Furthermore, a trend in the mortality of leaves from outside to inside and bottom to top of the canopy could be picked up with both instruments. The drawn conclusions also applied to the data from two foregone trials. With further modifications to the system that we intend to perform in 2013, we may be able to detect drought stress in time and take action before tree productivity starts to seriously deteriorate.

Session 6 - Pressures on pollinators and their functioning in ecosystems'

Chairs: Alexandra-Maria Klein, Dave Goulson

O1 - Global threats to wild bee populations

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Habitat loss has long been regarded as one of the main drivers of long-term pollinator declines, particularly the loss of flower-rich habitats such as species-rich grasslands. However, new threats have emerged. The global transport of honeybees, bumblebees and some solitary bee species for pollination has led to a substantial but poorly quantified redistribution of bee parasites around the world, exposing naïve bees to novel diseases with devastating consequences. I will describe one ongoing example from South America where the introduction of non-native bumblebees is leading to the extirpation of native species. Controversy rages over the importance of a second threat; the role of neonicotinoid pesticides in driving bee declines. These widely used systemic pesticides are found in the pollen and nectar of treated crops such as oilseed rape, and so are consumed by wild and managed pollinators at low concentration. Although these concentrations are not generally sufficient to cause rapid mortality, there is strong evidence that they impair navigation and pollen collection, and also reduce egg laying in bees. I will summarise evidence which strongly suggests that this class of pesticides is likely to be having a significant negative impact on wild bumblebee colonies. There is an urgent need to find means of protecting crops against pests without impacting on beneficial insects such as bees that provide vital ecosystem services.

O2 - Multiple stressors on honey bee health

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Severe losses of managed honey bee, *Apis mellifera*, colonies are believed to occur because of environmental stressors such as introduced parasites and changes in land-use. As honey bees rarely encounter a lone stressor in the environment, considerable attention towards understanding the influence of stressor combinations is paramount to explain and mitigate losses. Here we will give an overview on stressors and will focus on the interactions among pathogens and between pathogens and neonicotinoid pesticides. Evidence accumulates that combined effects of such stressors can have dramatic effects. However, data are scarce at present and honey bees remain notoriously difficult model organisms due to the high buffering capacity of colonies. Indeed, significant effects at the individual bee level are often blurred at the colony level. More research is required to determine oney bee colony collapse thresholds for pesticides and pathogens and to better understand mechanisms by which pesticides and parasites interact in the host.

O3 - Is plant resin important for bees?

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It is widely known that bees collect pollen and nectar from flowering plants to feed their larvae and themselves. That some bees, particularly the highly social honeybees and tropical stingless bees, also collect substantial amounts of plant resins is far less known.

Bees use resin not only to construct their nests and to protect and defend their colonies, but also to strengthen their social immunity and to increase the chemical and functional diversity of their cuticular profiles. In spite of all these functions, researchers have so far paid little attention to the role of plant resins for bees.

We are studying the collection and use of resin as well as the influence of landscape-related availability and diversity of resin-providing plants on the collection behavior and health of European honeybees and tropical stingless bees. For both temperate and tropical regions, we revealed a broad spectrum of resin sources visited by bees. However, the diversity of resin sources collected depends on the surrounding landscape and hence plant diversity and is reduced in intensively used agricultural areas, such as, for instance, macadamia plantations. We could further demonstrate that a mixture of different resins is more efficient in repelling pests, such as the small hive beetle (*Aethina tumida*), or in inhibiting the growth of common lab microbes than single resins, indicating that bees strongly benefit not only from resin itself, but also from a diversity of different resin sources. Resin may thus play a strongly underestimated key function in the wellbeing of bees.

O4 - The role of nesting resources and competition between honey bees and wild bees in the Lüneburger Heath

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The European honey bee exploits floral resources very efficiently and may therefore compete with solitary wild bees. Hence conservationists and bee keepers are debating about the consequences of honey bee management for the conservation of wild bees in nature reserves. We studied if wild bees visit fewer flowers when honey bees are abundant and if this affects their reproductive success in the Lüneburg Heath, Germany.

We observed flower-visiting bees on common heather, *Calluna vulgaris* flowers to study the resource use of bees on plots with honey bee hives present and absent and on plots differing in the distance to the next hive. Additionally, we counted the number of wild bee stem nests and stem-nesting bee species on plots with honey bee hives present and absent as well as the number of wild bee ground nests on plots that differ in their distance to the next honey bee hive.

We found that on plots that are in direct proximity to honey bee hives (≤150 m) wild bees visit fewer flowers while honey bee flower visits increase. However, we did not observe fewer honey bee flower visits or higher wild bee flower visits when sites were located in increasing distances (up to 1,229 m) to the next hive. The reproductive success of stem-nesting and ground-nesting wild bees was not affected by the distance to honey bee hives or their presence but by characteristics of nesting resources. However, we found fewer numbers of stem-nesting bee species on sites with honey bee hives than on sites without hives whilst Shannon diversity did not differ.

Our results suggest that current honey bee management in the Lüneburg Heath does not compromise wild bee reproduction. Future research needs to include different honey bee stocking rates and conservation efforts need to prioritize the enhancement of nesting resources.

O5 - Living fencerows promote gap crossing behavior in hummingbirds

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Worldwide, nine out of ten flowering plant species are pollinated by animals. Thus, halting the worldwide pollinator decline constitutes a global key challenge. Habitat fragmentation and loss such as tropical deforestation are main drivers of extinction, but “rescue effects” by enhanced connectivity can restore populations. Further, pollinators as gene vectors need to move between fragmented plant populations for efficient cross pollination and understanding how pollinators behave in fragmented landscapes is hence necessary to inform sound conservation actions. Living fencerows are hypothesized to facilitate inter-patch movements in tropical pollinators such as hummingbirds, but a lack of scientific evidence still limits their usefulness in conservation planning. By combining correlational and experimental approaches, we investigated the significance of living fencerows for the maintenance of hummingbird pollination in a highly fragmented landscape in southern Costa Rica: By placing artificial feeders and ornithophilous understory herbs (*Heliconia tortuosa*) in a highly replicated split plot design, we first found that forest-specialist hummingbirds are more often left the forest along living fencerows than through pasture. Second, the use of fluorescent dye as a pollen substitute showed that hummingbird mediated pollen movement is most likely through forest and least likely through pasture, but that living fencerows can partly compensate for this. Third, we tested whether the behavioral response of forest-specialist hummingbirds to living fencerows leads to differences in reproductive parameters of isolated versus connected populations of *H. tortuosa*.

O6 - (Induced) intraspecific variation in functional plant traits affects interacting communities at flowers and leaves

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Plants interact with diverse communities of animals that belong to different functional groups; examples are herbivores, florivores and pollinators. Functional plant traits such as morphological, visual and olfactory properties as well as resource quality and quantity, increase or decrease the interaction strength with these organisms. Conversely, interactions may alter the phenotype of plant individuals and thus the frequency and outcome of subsequent interactions with species of the same or different functional groups.

For few plant species, we quantified a) the natural intraspecific (co-) variation of plant traits, b) the inducibility of variation after interactions with herbivores and flower visitors and c) the interaction strength between insects and leaves or flowers under consideration of the phenotype of plant individuals. Overall, intraspecific variation in plant traits was marked. The degree of co-variation was pronounced within flower traits, suggesting an integrated phenotype of flowers that may maintain their functionality despite variation. Interactions at leaves induced changes in flower traits. Individual traits were less attractive for flower visitors after these changes; an effect that may, however, be attenuated by the variability of other traits.

The results presented here demonstrate that the phenotype of plants is subjected to several biotic influences and that plant-animal interactions are affected by previous interactions even on different plant parts. This leads to the conclusion that comprehensive datasets on interactions with several functional groups are needed to understand the selective pressures acting on functional plant traits.

O7 - Early mass-flowering crops mitigate pollinator dilution in late-flowering crops

Verena Riedinger[1], Ingolf Steffan-Dewenter[1], Andrea Holzschuh[1]

[1]University of Würzburg, Würzburg, DE, verena.riedinger@uni-wuerzburg.deWorldwide pollinator decline is caused not only by loss of nesting sites, which are mainly found in semi-natural habitats,

but also by loss of food resources. Mass-flowering crops provide a valuable food resource during a short period of time. Previous studies have shown that mass-flowering crops can dilute pollinator densities and constrain pollination services in semi-natural habitats. Effects of a mass-flowering crop on pollinators might exceed the flowering period itself by affecting population dynamics and enhancing pollinator densities later in the season. However, it has not been studied so far, how temporal landscape-scale interactions between two crops with non-overlapping flowering periods affect pollinator dynamics, and how the early-flowering crop influences pollinator visitation and yields in the late-flowering crop.

Within the STEP project (Status and Trends of European Pollinators) we studied densities of three pollinator groups (bumblebees, hoverflies and honeybees) on sunflower fields as a late mass-flowering crop in 16 landscapes that differed in the percentage of oil-seed rape as an early mass-flowering crop, in the percentage of sunflowers and in the percentage of semi-natural habitats.

In landscapes with a low percentage of oil-seed rape in spring, bumblebee densities decreased with an increasing percentage of sunflowers in the landscape in summer (dilution effect). In landscapes with a high percentage of oil-seed rape, no dilution of bumblebees in sunflower fields was found. These findings indicate a spillover effect from oilseed rape to sunflower fields. However, other pollinator guilds showed no significant effects. We conclude that the management of landscape-scale patterns of early and late mass-flower crops could be used to enhance densities of pollinators in crop fields and to ensure crop pollination services.

O8 - Land-use impact on foraging and pollination behavour of bees on Cotton plant and Pigeon pea at Dang (Ngaoundere, Cameroon)

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Human activities such as bush clearing, bush fire, livestock over-stocking, pesticides use and smoking to repel insect pests are the main factor affecting the health of an agroecosystem and, usually affect both the bee population and it activity on crop flowers. To evaluate their impact on foraging behavior of bees on *Gossypium hirsutum* L. (cotton plant) and *Cajanus cajan* L. (Pigeon pea), bee's foraging and pollinating activities were studied in Ngaoundéré for two years (2010 and 2011). Observations were made on flowers and, we focused more on 340 flowers per studied plant during its flowering period from June to October each year. On cotton plant, we recorded, 23 insects species (2010) and 13 insects species (2011) visiting its flowers among which we recorded 09 bees species belonging to 03 families (2010) and 08 bees species belonging to 02 families (2011) . The most frequent bee on cotton plant was *Apis mellifera adansonii* L. with 1712 visits in 2010 and 1673 visits in 2011. On Pigeon pea, we recorded 20 insects species (2010) and 19 insects species (2011) visiting its flowers among which we recorded 16 bees species belonging to 03 families (2010) and 15 bees species belonging to 03 families (2011) . The most frequent bee on Pigeon pea was *halicodoma*

sp. with 1911 visits in 2010 and 1958 visits in 2011. The number of colonies varied from 31 (June 2010) to 51 (October 2010) and from 17 (June 2011) to 27 (October 2011). The mean number of workers getting into the hive without pollen varied from 60.44±31.33 in June 2010 to 85.99±26.19 in October 2010 and the mean number of workers getting into the hive with pollen varied from 23.88±34.44 in June 2011 to 44.27±43.13 in October 2011. The mean number of workers getting into the hive without pollen varied from 59.49±32.34 in June 2010 to 95.44±18.89 in October 2010 and the mean number of workers getting into the hive with pollen varied from 23.84±24.44 in June 2011 to 51.49±42.82 in October 2011.

Key words: *Gossypium hirsutum*, *Cajanus cajan, Apis mellifera adansonii*,*Chalicodoma* sp. foraging

O9 - Homegarden management cannot compensate pollination deficiency to cucumbers in Indonesia

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Insect pollination is an essential ecosystem service to achieve high production in many crops but pollination services are today threatened by habitat destruction, diseases, and extensive applications of agro-chemicals. Little is known on how pollination is interacting with possible post-pollination processes affecting yield. Environmental variables such as nutrient resources for the plant, weed pressure, and herbivory can strongly affect early fruit abortion or fruit or seed quality and therefore invalidate crop pollination services.

We tested the individual and combined effects of insect pollination with other environmental variables limiting fruit maturation: nutrient deficiency, weed pressure, and herbivory, on fruit set and yield of cucumber (*Cucumis sativus* L.) in 13 traditional Indonesian homegardens. We conducted pollination treatments (open and bagged pollination) in a full factorial split plot design with high and no weed pressure (with and without herbicide application), high and low herbivory (with and without insecticide application), and high and low resource input (high and low fertilization).

We found that insect pollination is the most important factor determining fruit set and yield in cucumber, followed by conditions of higher nutrient input and lower weed competition. The insecticide treatment – to reduce herbivory– had no effect on fruit set and yield. We conclude that although multiple variables affect crop yield, they do not compensate total pollination deficiency in cucumber smallholder production in Indonesia.

O10 - Function diversity matters: the importance of conserving complementarity and response diversity for soft-fruit production

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Although commercial pollinators are generally assumed to be good substitutes of wild pollinators, there is increasing evidence that the use of one commercial pollinator species cannot adequately replace the functions provided by a diverse assemblage of species. Slight differences in pollinator function between taxa can increase overall production if such differences are complementary. I present data from one such crop with requirements for multiple taxa. Strawberries in Scotland have an extremely long growing season, flowering from April to August. The needs of strawberries are unlikely to be met by one species alone as different pollinator taxa peak at different points in the season. We observed seasonal complementarity between different pollinating taxa in a large-scale field study in Scotland. Observations were made throughout the entire growing season, and pollinators were excluded from areas for a direct measure of yield improvements. Farm with more complementary groups would have higher yield than those with a lower number of groups. Species groups also showed varying responses to changes in different weather variables, presenting a second axis along which diversity could be important for strawberry production. While these findings strengthen the argument for preserving pollinator diversity, they present a challenge for farm managers who need to manage different pollinator groups (including commercial ones) for overall services. While strawberries are a specific example, differences among other axes will be important for many crops, I will describe a generalised framework for evaluating such differences and how it can inform economic valuation of pollinators, as well as assist management planning.

O11 - Context-dependent importance of honeybee pollination

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Honeybees (*Apis mellifera*L.) are important crop pollinators, but whether their importance can change in response to crop field heterogeneity is unclear. We analysed how the abundance of honeybees in local bee community influences crop yield along transects from strawberry field edges to centres. Bees on strawberry flowers, strawberry fruits as well as pollen samples from honeybees were collected. Strawberries were visited by 24 bee species with honeybees being most abundant. Honeybee pollination was most efficient at the field centre, but exhibited a negative effect on

trawberry yield at the field edge. This changing importance of honeybees was supported by higher heterospecific pollen loads carried by honeybees at the field edge than in the field centre. Strawberry pollination at the field edge was most efficient when provided by evenly distributed bee communities, with Evenness being negatively related to the abundance and proportion of honeybees. We conclude that efficient pollination of strawberries cannot be conducted by honeybees alone, due to the shown context dependency of honeybee pollination success. Both honeybees and wild bees are needed to provide efficient strawberry pollination all over entire fields and declines of either bee group will cause serious declines in strawberry yield.

O12 - Pollination of apple varieties across Europe: dependency on cross pollination and visitor communities

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Pollinators, particularly bees, are of crucial importance for apple pollination, as most varieties require cross-pollination with compatible polliniser trees to set fruits. Although a large number of wild bee species have been recorded visiting apple flowers, we do not have information on whether different varieties attract distinctive communities of flower visitors, and whether this is related to varying levels of dependency on cross pollination.

The overall objective of this research is to compare the abundance, diversity and community structure of flower visitors in apple orchards between varieties and countries. We hypothesise that i) varieties vary in their dependency on cross pollination and insect visitation, ii) the diversity of visitor communities differs between varieties and that iii) the structure of these communities varies across Europe.

We investigated these questions in four locations (UK, Germany North, Germany South and Hungary). For the first hypothesis, we carried out bagging experiments on five varieties. Pollination treatments included hand pollination with cross and self pollen, no pollination, wind pollination and open pollination. For the second hypothesis, we surveyed the abundance and diversity of insect species visiting flowers in eight apple varieties in commercial orchards using transects and timed tree observations. For the third hypothesis, we selected a variety common to all study countries and carried out the same surveys as for the second hypothesis.

Here we present preliminary results from this study and discuss the implications that variability in both breeding systems and visitor communities has on orchard production.

P1 - Increasing temporal synchrony between syrphid flies and their floral resources despite differential phenological responses to climate change

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Climate change may lead to temporal mismatches among interacting species because of interspecific variation in responses to abiotic phenological cues. Both plant and pollinator phenologies respond to recent climate change, but datasets containing both groups at the same location are rare. Syrphid flies are widely considered to be the second most important group of pollinating insects, following bees, and here we examine a long-term record of syrphid fly and flower phenology from 1992-2011 at the Rocky Mtn. Biological Laboratory. We investigated the abiotic environmental cues associated with the timing of peak abundance of syrphid flies and of flowers of six plant species commonly visited by syrphids. We used simple linear regression to describe relationships of phenology to climate variables (air temperature, precipitation, and timing of snowmelt). Because insects require a certain degree of heat accumulation or vernalization to break diapause, we also included the number of days on which temperatures warmed above freezing as a potential explanatory variable. Important predictors were chosen based on AIC scores.

Syrphid flies and the flowers they visit respond to different phenological cues (heat accumulation and precipitation vs. snowmelt, respectively). The timing of syrphid peak abundance is shifting later in the season (10.0 ± 4.6 days/decade; mean ± 1 SE throughout). Syrphids peaked 1.8 ± 0.9 days earlier in years with each additional day that warmed above freezing in the early spring. Counterintuitively, there is a significant trend toward a decreasing number of days that warm above freezing in the early spring, because of decreasing average maximum temperatures (and no change in average temperatures). Syrphids peaked earlier in years with less rainfall in June (5.4 ± 0.9 days earlier/ 1 cm decrease). Rainfall is decreasing more slowly than the trend in days warming above freezing, resulting in delayed syrphid phenology. Most plant species trended toward advanced flowering, but there were no significant changes in flowering phenology. Interspecific variation in peak flowering relative to peak syrphid abundance resulted in converging (3 cases), diverging (1 case), and no change (2 cases) in syrphid phenology relative to flowers. Widespread phenological mismatch, then, seems unlikely.

P2 - How green infrastructure can mitigate the consequences of climate change

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Climate change is expected to affect species distributions. Consequently, species will have to move through the landscapes in order to track suitable climatic conditions. In this sense, landscape structure and connectivity are fundamental for species persistence in the face of future changes.

In the present study we aim to understand how landscape structure can facilitate or constrict species range shifts. We investigate landscape permeability by evaluating the movement potential of species shifting their ranges. In addition, we assess the effect of landscape structure on maintaining robust communities investigating species potential to persist go extinct or colonize new areas.

To this end, we use data from 6 different field sites analysing 16 local pollinator communities per site. Abundance data for bee species within each community are collected yearly since 2010 (6 times per year within intervals of 2 weeks). To assess the functional connectivity of different landscapes we focus on the synchrony in population dynamics of each species; synchronized dynamics are reported to indicate high exchange of individuals and, thus, well-connected populations, while isolated populations are more likely to display asynchronous dynamics. Subsequently, we implement a series of connectivity metrics in order to infer whether the observed synchrony patterns emerge as a result of functional connectivity or are affected by factors such as climatic parameters and land use. Additionally, the effect of landscape configuration is assessed for species groups defined by different trait combinations such as body size or dietary breadth. The results regarding functional connectivity and persistence of different species groups are assessed in the context of future scenarios for the implementation of Green Infrastructure. Thus, important landscape features for species movement are identified and used as cornerstones in the development of future scenarios for maintaining pollination services.

P3 - The impact of crop selection, surrounding habitats and weed densities on pollinator occurrence in the agricultural landscape

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Pollinators play a decisive role in the agricultural landscape, providing ecosystem services to crops and wild plants by pollinating them. However, there is a substantial decline of many pollinator populations all over Europe. The objective of the study was to reveal correlations between the occurrence of different pollinator species and several environment parameters. We collected data for three years within different crops at three different locations in Germany. The response variable was divided into different ecological groups based on number of generations, social behavior, nesting side and activity period of the species. Using statistical modeling we showed the effect of weeds, blossom abundance, crop species, vegetation structure of the crops, surrounding biotopes and previous crops on the occurrence of pollinators. We discussed the relevance of these relationships in order to make predictions about the species occurrence in different cultivation systems and to assess these cultivation systems (for instance different kinds of energy plant cultivation) with regard to biodiversity-friendly farming.

P4 - Natural habitat loss and exotic plants reduce the functional diversity of pollinators in a heterogeneous subtropical landscape

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1. Natural habitat loss and exotic plant invasions are major drivers of global change that modify patterns of biodiversity. Loss of biodiversity may thereby result in reduced functional diversity (FD) in species communities. Although FD is directly related to ecosystem processes and functioning, additive and possibly interactive effects of multiple global change drivers on FD have rarely been addressed.

2. Here we focused on insect pollination as an important ecosystem process. In a subtropical South African landscape, we investigated changes in the FD of pollinator assemblages on native and exotic plants along gradients of natural habitat loss and relative exotic plant abundance. We used a dataset of 1414 pollinator individuals sampled on 131 plant individuals and calculated the FD of three pollinator traits which are strongly related to pollination processes and plant-pollinator interactions: proboscis length, proboscis diameter and body length.

3. Multivariate FD of pollinators decreased along both gradients, i.e. with increasing loss of natural habitat and relative abundance of exotic plants. Importantly, changes in FD exceeded those in pollinator richness. Thereby, these changes seemed to be mediated by complementary negative effects of natural habitat loss on FD in proboscis length and relative exotic abundance on FD in body length, respectively. Correspondingly, we recorded a loss of long-tongued pollinators with natural habitat loss and reduced variance in body size with both drivers. In contrast, FD in proboscis diameter was unaffected by either driver. All effects of the two global change drivers were non-interactive.

4. Our results show that both natural habitat loss and exotic plants negatively affect pollinator FD, which may imperil pollination of specialised plant species in degraded habitats. Pollinator richness is a poor representative of pollinator FD and likely to be insufficient when assessing the consequences of disturbances on pollination processes. Distinct responses of pollinator traits to the two drivers suggest limited options to infer relations of one trait to another. Finally, additive effects of natural habitat loss and exotic plant invasions highlight the need to consider multiple drivers of global change when investigating ecosystem processes at a community scale.

P5 - Cross-pollination benefits differ among oilseed rape varieties

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Winter oilseed rape (*Brassica napus*) is an important crop for human consumption and biofuel production and its production is increasing worldwide. It is generally assumed that cross-pollination by insects increases oilseed rape yield but testing of this has been restricted to a few rapeseed varieties and produced varying results. Here, we determine whether cross pollination benefits a number of oilseed rape varieties by comparing yield in the presence and absence of insects.

We used four rapeseed varieties (Sherlock, Traviata, Treffer and Visby) with ten individuals each in four pollination treatments: (1) supplementary hand-pollination, (2) open pollination with insects able to access the flowers, (3) wind pollination and (4) autonomous self-pollination.

Across all four varieties, open and supplementary hand-pollination treatments resulted in higher fruit set, numbers of seeds per pod and yield compared to wind and self-pollination. The cross-pollination benefits, however, differed among rapeseed varieties whereby plants of the variety Treffer and Visby had a higher dependence on open (insects) and supplementary cross-pollination than Sherlock and Traviata. Across all four varieties, seed weight compensated for reduced fruit set and was highest when plants were self-pollinated. Our results highlight the importance of considering varietal differences in crop pollination research. Information on the pollination requirements of crop varieties is required by farmers to optimize management decisions in a world of increasing agro-pollination deficits.

P6 - Assessing the impacts of farming system and biogeographic region on insect-pollinated plant diversity in cereal crops and permanent grasslands

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Recent evidence suggests that insect-pollinated plants and their pollinators decline in parallel. In Europe, intensification of farming practices lead to changes in plant community composition towards a lower proportion of flowering plants, therewith affecting the structure of plant-pollinator networks in agricultural habitats.
In this study, we investigated the impacts of biogeographic region, farming system (organic vs. conventional), land-use type (cereal crop vs. grassland) and pollination type (insect-pollinated vs.

non-insect pollinated) on the number of forb species using linear mixed-effects models. In addition we tested the effect of biogeographic region, farming system and land-use type on the proportion of insect-pollinated forb species relative to all forbs. A total of 53 matched pairs of organic and conventional farms were selected in four different biogeographic regions in Germany. On each farm, forb species were identified within the field centre of cereal crops (mostly winter wheat) and permanent grasslands, respectively. In total, 66 cereal fields and 40 grasslands were surveyed.

Organic fields had more insect and non-insect pollinated forbs compared with conventional fields except for the number of non-insect pollinated forbs in grasslands that did not differ. Cereal crops contained more non-insect pollinated than insect-pollinated forbs, while grasslands generally contained more insect-pollinated than non-insect-pollinated forbs. The proportion of insect-pollinated forb species relative to all forbs was higher in organic fields irrespective of land-use type. These effects were congruent across biogeographic regions, but the effect size varied. Our results indicate that organic farming is beneficial to insect-pollinated plant species in both cereal crops and grasslands, and may therefore be favorable to pollinator communities.

Session 7 - Relationships between biodiversity, ecosystem functions, services and / or management of coastal and fresh-water wetlands in response to environmental change

Chairs: Jasmin Mantilla-Contreras, Michael Kleyer, Vanessa Minden

O1 - Scenarios of coastal land use change and consequences for breeding birds along the German coast

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The collaborative research project COMTESS (Sustainable Coastal Land Management: Trade-offs in Ecosystem Services) studies possible future changes in land management at the German North Sea and Baltic Sea coast. Different scenarios of land use adaptation to sea level rise and changes in precipitation are investigated under ecological and socio-economic aspects. The scenarios involve the construction of polders in the hinterland of the current dike, which could serve as water reservoirs and prevent salt water intrusion. Depending on the scenario, there could be either development of large reed beds with subsequent peat formation or a mosaic of smaller water bodies and extensively managed grasslands within the polders. These different land use strategies lead to significant changes in the breeding bird community at the German coast. These coastal ecosystems provide habitats for substantial fractions of populations of critically endangered meadow bird species, for example Black-tailed Godwit, Redshank or Lapwing. This study investigates the impact of the different COMTESS scenarios of land-use change on breeding bird diversity and the composition of the breeding bird community. Breeding bird surveys were conducted in 2012 and 2013 on 200 study plots at the North Sea and Baltic Sea coast, representing the most important coastal vegetation types at the foreshore and inland. A space-for-time approach will be used to predict future breeding bird communities in the different scenarios.

O2 - Functional trait expression along gradients of salinity and water availability in coastal plant communities

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Understanding the factors driving community assembly is a fundamental question in community ecology. It is well-established that species interactions (biotic factors), environmental factors (abiotic factors), and neutral processes drive community assembly. However, disentangling the relative importance of these processes still remains a task to do. Here, we take a functional trait-based approach to assessing the mechanisms that constrain community assembly in response to abiotic conditions by investigating the convergence and divergence of plant functional traits within and between communities along gradients of salinity and water availability in coastal areas.

Based on the assumption of limiting similarity, biotic filters are generally considered to cause a diversion of functional traits within a plant community (high functional diversity); however, they can also cause convergence when a dominant species outcompetes species with contrasting traits. Abiotic filters are mainly considered to cause functional convergence (low functional diversity) by sorting species with certain trait expressions.

We expected strong trait-based species sorting along the abiotic gradients with increasing biotic filtering towards the more benign end of the abiotic gradients. We also expected that variations in species composition were trait-neutral when considering only short sections of the abiotic gradients.

The study sites were situated in four areas along the North Baltic Sea coast. For 200 plots we recorded salinity, inundation, soil water availability, soil nutrients, and disturbance, as well as plant species frequency and form and mass-based traits.

The results generally confirmed our expectations. However, strong convergence based on biotic filtering also occurred at intermediate levels of the salinity gradient and was not confined to its more benign end. Our study gives new insights in the functional mechanisms that constrain community assembly in response to abiotic conditions.

O3 - Effects of environmental parameters, land management and plant diversity on productivity of coastal wetlands of the North and Baltic Sea

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Plant diversity and primary productivity are affected by several parameters including environmental gradients, disturbances and land management. The coastal wetlands of the North Sea are characterized by a relatively large tidal amplitude and salinity level, whereas the coastal habitats of the Baltic Sea coast are characterized by a low or negligible tidal influence and a lower salinity level. Such differences have a major influence on the plant species diversity and biomass production in these areas. In addition, land management has a high impact on the vegetation performance.

Within the collaborative research project *COMTESS*, which deals with trade-offs between ecosystem functions and services in respect to climate change and future provisions for coastal protection, we analyzed the effects of environmental parameters, land management and disturbances on plant diversity and its influences on the productivity of the North and Baltic Sea.

On 200 plots in the Netherlands, Germany and Denmark, we analyzed plant species responses to environmental conditions and disturbance regimes in coastal and fresh-water wetlands (brackish and freshwater meadows and grasslands)along soil water availability, salinity and disturbance gradients. On all plots, vegetation parameters, groundwater level, salinity, soil nutrients and disturbance type and intensity were determined.

We found high species diversity on intensively used sites and a low diversity on sites with no current land-use, probably because of the domination of reeds in abandoned areas. Because of the high productivity of reed stands, we found the highest biomass production in unused areas and biomass production decreased with usage intensity. Corresponding to salinity as a strong environmental filter in the assemblage of plant communities, we found that species diversity decreased with increasing salinity.

O4 - Interaction of tidal hydrodynamic and marsh vegetation in the Elbe estuary

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Structure and functionality of tidal marsh vegetation are permanently subject to changes. In order to comprehend and reproduce general patterns of vegetation expansion and recession, it is necessary to understand the underlying processes. 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*. For this purpose we monitored the growth of both species in two study areas along the river Elbe. During one growing season, we monthly measured plant density, height, number of leafs and flowers as well as biomass on transects lateral to the shore. In the subsequent growing season we once quantified the above and below ground biomass of both species. We furthermore measured temperature, light intensity, current velocity in and outside vegetation, inundation height, length and frequency and soil water salinity. Statistical analyses well known from species distribution modeling studies were used to analyze the linkage between habit and vegetation growth. First results suggest that spatial variability of plant growth is very high. However, our data confirm that tidal inundation frequency is an important factor for the growth of both species and suggest that feedbacks between current and vegetation are particularly strong: current velocity has a pronounced effect on growth and morphology of *Bolboschoenus maritimus* whereas the plants reduce current velocity. The identified effect and response curves provide valuable insights into the species response to measured environmental factors on the one hand and the effect of the vegetation on flow velocity on the other hand.

O5 - Changes of mangrove distribution patterns in Central Vietnam: succession after natural disturbances and human interference

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Due to unsustainable land use practices, rapid urbanisation and coastal development processes, mangrove areas are becoming increasingly destroyed or degraded world-wide. This applies also to Vietnam, where population growths and a rapid economic development put a particularly high pressure on coastal ecosystems. Additionally, Vietnam’s coastal zone is threatened by sea level rise due to climate change. In the present study, the drivers of changes in the distribution patterns of mangrove communities are explored and the potentiality of natural regeneration of mangroves species is investigated.

In a first step, current tree diversity patterns of Tam Hoa Lagoon in Quang Nam Province in Central Vietnam were mapped to identify mangrove areas of different successional stages and human interference. Then, forest and land cover changes in the mangrove ecosystem were investigated for the period from 1990 to 2012 using high resolution satellite imaginary and community-based mapping. In a third step, the mangrove losses of that period were classified according to the drivers: (a) aquaculture, (b) agriculture, and (c) natural disasters such as typhoons and coastal flooding. The combination of these three analyses allows drawing conclusions on the potential for natural regeneration of mangrove communities. Moreover, the results provide a better understanding of the resilience of mangrove ecosystems and can contribute to mangrove restoration measures in Tam Hoa Lagoon, and Central Vietnam in general.

O6 - Lake Alaotra wetlands: ecological trends in the most important rice and fish production region of Madagascar.

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Madagascar is well renowned for its unique biodiversity. The Lake Alaotra, with 20,000 ha open water body and 23,000 ha fresh-water marshes represents Madagascar's largest wetland system, hosting several endemic species. The Alaotra region is also of high agro-economic importance. It constitutes the biggest rice and freshwater fish production site in Madagascar. However, a fast growing population lacking alternative incomes beside farming and fishing puts the wetland systems under growing pressures: marshland conversion into rice fields, erosion from deforested hills, lake siltation, acidification, high use of fertilizers and pesticides and introduction of invasive species (e.g., *Eichhornia crassipes*, *Channa maculata*).

This study assessed the current ecological status of the Lake Alaotra. It compared water quality, plant diversity and composition and abundance of aquatic invertebrates and *E. crassipes* with the last comprehensive survey done some 20 years ago. The study was implemented at three sites reflecting differing intensities of human marshland use, characterized by marsh degradation, extent of agriculture and leakage of anthropogenic nutrients. The environmental parameters were assessed during the period December 2012 - April 2013. Nine transects of 220 m each were installed per site. A total of ten 1 m^2-plots per transect were sampled, five in the lakeshore vegetation and open water, respectively.

The survey shows an aggravated condition of the lake and the surrounding marshes. A disturbed lakeshore plant composition combined with increased abundance of *E. crassipes* and a reduced abundance of other aquatic plants (e.g., *Nymphaea nouchali*) have been linked to sites with high marsh utilization. First results indicate that allochthonous species such as *E. crassipes* and *Salvinia* spp. might provide a more complex and preferred habitat for aquatic invertebrates; however, the oxygen levels there are reduced. Generally, the acidity levels of the lake have increased over the past 20 years.The understanding of causes and consequences of ecosystem changes will help informing local management authorities. This will help to achieve a better balancing of the unique biodiversity with agronomic activities and cultural important values to ensure a sustainable future for local people.

O7 - *Eichhornia crassipes*, opportunity or threat for biodiversity conservation at Lake Alaotra, Madagascar?

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Madagascar, famous for its unique biodiversity, is experiencing extensive deforestation leading to massive hill slope erosion. At Lake Alaotra, environmental problems are present such as marsh burning, eutrophication with chemical fertilizers, lake siltation and invasion of allochthonous species. The water hyacinth (*Eichhornia crassipes)* is present almost all over the Alaotra wetland system causing several ecological and economic problems.

We tested the opportunities and limitations for the use of *E. crassipes*. The socio-economic assessment allows identifying potential drivers and barriers for the utilization of *E. crassipes*. Survey and focus groups were administered in three villages representing gradual differences of marsh degradation. First results indicate differences in the readiness to use *E. crassipes* between the test sites and amongst various stakeholder groups.

We also tested *E. crassipes*' utility as compost (aerobic vs. anaerobic). Ten growth experiments with salad have been performed. Comparisons were made with cow dung and industrial fertilizer (urea). Measurements were taken every three days; growth (length, diameter), the number of leaves, thickness, color, and plant resistance against insects. The first results show increased plant vigor with *E. crassipes* composts and cow dung, and poor growth with green manure and urea. *E. crassipes* compost can replace cow dung, which is rare and expensive. It can reduce the usage of chemical fertilizers, which affects water quality and fosters invasive plant species growth in the area. Further, new techniques were taught to local artisans to utilize *E. crassipes* in lieu of e.g., *Cyperus madagascariensis*, an important food item of the critically endangered Alaotran gentle lemur (*Hapalemur alaotrensis*). For the economic analysis all the costs (time, material, human resources) and consent prices have been recorded.

The conservation of the Alaotra wetlands is not only crucial for the livelihood of many people living in the area, but also for many endemic species. Every conservation measure should always offset the opportunity cost for the local population not to depend entirely on the natural resources for livelihood. Searching for new "in-house" economic alternatives might represent a feasible solution to slow down the loss of Alaotra's biodiversity.

P1 - AMBio MADAGASCAR - Biodiversity conservation at the lake Alaotra, Madagascar

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Madagascar is known for its highly endemic biological diversity and its unique ecosystems. However, the country faces strong environmental degradation, low agricultural productivity and poverty. The lake Alaotra wetland complex is of high ecological and economic importance but also undergoes strong ecological degradation. A majority of the marshland fringing the lake has already been converted for rice production. Increased erosion from the deforested hills, lake siltation, acidification, high use of fertilizers and pesticides and the introduction of invasive species (e.g., *Eichhornia crassipes*, *Channa maculata*) are further problems, causing negative environmental and economic impacts. Many species have been already extinct or are now critically endangered such as the Alaotran gentle lemur (*Hapalemur alaotrensis*) which is endemic to the Alaotra region. Fish and rice production have dropped due to the high degradation of the wetland system.

Since 2012, the project AMBio (Alaotra Marshland Biodiversity) MADAGASCAR is run as a collaboration between the University of Hildesheim and Madagascar Wildlife Conservation, and aims to gain a better understanding of the Alaotra socio-ecological wetland system to inform policy and decision makers for adapting management and conservation practices to balance conservation with development needs: a region-wide assessment of the ecological integrity of the lake and its surrounding marshlands allows to compare today's conditions with surveys done 20 years ago; assessing drivers and barriers of environmental education at the primary teachers' level allows to focus on the efficacy transmitting conservation values and appreciation to future resource users; a third component of the research works on the development of alternative resource use options for improving the resource users' livelihoods by focusing on the utilization potential of *Eichhornia crassipes* (e.g., the use of the invasive water hyacinth as handicraft, briquettes or compost). We will give an overview of the project and present the first results.

P2- Sustainable management and DRR of Mangrove-forest in Pemba-bay, Mozambique

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Mangrove ecosystems are highly vulnerable to human and environmental impacts, and in particular to hazards like floods. Although there are many studies about these coastal ecosystems, the programs to manage them have not been sufficient for their conservation, as actual studies show declining extensions of the mangrove areas worldwide.

Many income generating human activities such as fishing, firewood and chalk-coal production depend on intact mangrove ecosystems. Therefore, it is not only important to focus on the conservation of these ecosystems, but also on the economic development of socio-economic structures for the people depending of these ecosystems. Payment for Ecosystem Services (PES) are an instrument to protect these ecosystems by giving incentives to people for maintaining the ecosystem services. In addition, such preservation of coastal ecosystems helps to reduce the impacts of hazards occurring in human settlements near these areas, which is further threatened by the increasing interest in new found oil and gas deposits in northern Mozambique. Plans for the amplification of the existing harbour and extensions of roads for transport are been developed, without having sufficient knowledge about Flora and Fauna of the huge Mangrove-areas within the bay.

This study evaluated the current management in two mangrove ecosystems using mollusk, decapoda and tree species to derive the influence of human activities and their impact. Mollusks and Decapoda are suitable bio-indicators for the deduction of biodiversity and its services, due to their high sensitivity to changes in the environment and to the necessity of mangrove-areas for food supply and reproduction.

The proposal of sustainable strategies, considering both human well-being and ecosystem resilience, was a further goal of this study for the intention to create appropriate management suggestions for these vulnerable regions.

Session 8 - Multifunctional biodiversity

Chairs: Björn K. Klatt, Tim Diekötter

O1 - Biodiversity as an indicator of ecosystem service diversity in temperate rainforests

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The concepts of ecosystem services and biodiversity have become important frameworks to assess and improve ecosystem management towards more sustainable trajectories. Recent (social-) ecological research has increasingly focused on potential synergies between ecosystem services and biodiversity enabling a more informed and integrated ecosystem management.

We examined coastal temperate rainforests in the western US, which are the largest coherent extent of this ecosystem remaining on Earth. They offer a multitude of benefits to society, though are threatened by land use and climatic changes. To improve ecosystem management our main research questions are:

1) What are the linkage patterns between ecosystem services and species richness? 2) How is ecosystem service diversity connected to species richness and higher taxon diversity? 3) In what way do ecosystem service groups interact with species richness beside environmental parameters such as climate and land use?

Relationship patterns between the richness of four higher taxa: amphibians, birds, mammals & trees and 9 ecosystem services are analyzed. Ecosystem services are bundled into four groups: provisioning, supporting, regulating & cultural services. Diversity metrics are derived for higher taxa and ecosystem services using the Simpson diversity index. We applied generalized linear models incorporating spatial autocorrelation structures for linkage modeling. Constrained redundancy analyses are performed for multivariate modeling.

1) We derived a mixed set of linkages between species richness and ecosystem services showing mostly unimodal patterns. 2) Relationships between richness patterns of all higher taxa and the ecosystem service diversity are widely positive. Increased higher taxon diversity is mostly related to higher ecosystem service diversity. 3) All four ecosystem service groups have significant influence on species richness in a comparable magnitude of climate and land use.
Our results indicate that biodiversity may represent an appropriate indicator for multifunctional forest ecosystems from an ecosystem service perspective, which could aid an integrated ecosystem management.

O2 - Direct and biodiversity-mediated indirect effects of land-use intensity on multiple ecosystem processes

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Biodiversity is known to be important for maintaining high levels of ecosystem functioning and particularly for maintaining high levels of ecosystem multifunctionality. However, most of the evidence for positive biodiversity-functioning relationships comes from experiments and there is a pressing need to investigate these relationships in anthropogenic systems. We present an analysis of biodiversity-multifunctionality relationships in grasslands which vary in land-use intensity, from the German Biodiversity Exploratories project, which has 150 grassland plots in three regions of Germany. We analyse 13 distinct measures of ecosystem process, including measures of functioning such as carbon stocks, belowground productivity and decomposition as well as services such as natural enemy abundance and pollination. We find that increases in land-use intensity promote certain functions but reduce others. Using structural equation modelling we analyse relationships between land use, environmental variables and biodiversity. We show that, depending on the region, land-use can have direct positive effects on multifunctionality but also indirect negative effects caused by reductions in biodiversity. Our analyses contribute to understanding the importance of direct effects of land-use intensity, as well as indirect effects mediated through loss of biodiversity, on ecosystem functioning.

O3 - Increasing high and decreasing low performance strengthen diversity effects over time

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In biodiversity experiments, the relationship between biodiversity and ecosystem functioning is predicted to become stronger with time as the high-diversity communities are expected to develop towards higher complementarity. For example, a build-up of the soil community in the high diversity mixtures can lead to more efficient resource uptake. However, a diversity effect can also be caused by negative feedbacks at low diversity causing low performance of these communities. Consequently, diversity effects can become stronger over time by an increasing performance at high or a decreasing performance at low diversity (or both). The Jena Experiment is a large scale grassland biodiversity experiment in which a large number of ecosystem properties have been investigated over the last 10 years. Therefore, it offers the possibility to ask for the generality of increasing diversity effects with time which have previously documented for individual functions.
For about 100 ecosystem properties we analyzed the level of functioning against the natural logarithm of sown diversity (1 to 60 species) individually within every year. Effect sizes of the

diversity effect and performance at high and low diversity were extracted from these models and analyzed for temporal trends for every ecosystem property. We asked how frequent diversity effects become stronger with time and whether these changes are caused by low diversity plots doing progressively worse or high diversity plots doing increasingly well.

For many ecosystem properties diversity effects did become stronger over time as indicated by steeper slopes for the diversity effects. Stronger diversity effects resulted from an increasing performance of plots at high diversity (e.g. basal soil respiration and carbon concentrations in the soil), from a decreasing performance at low diversity (e.g. plant biomass and plant cover), or from a combination of both effects. Our results highlight the importance of long-term experiments because shorter term experiments might underestimate the effects of diversity. Also, we demonstrate that both changes in functioning at the low and high end of the diversity gradient can strengthen diversity effects over time. Consequently, mechanistic explanations for diversity effects should not only focus on increasing performance at high diversity.

O4 - Mapping ecosystem functions in a forest ecosystem: tree species distribution patterns in Central Vietnam

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Vietnam is one of the few countries in the world with steadily increasing forest coverage. Scarred in the years of the Vietnam War between 1965 and 1975, the vegetation has grown steadily since the early 1990s. However, the knowledge of the area covered by forest does not provide much information about the forest composition. This is all the more remarkable as Vietnam belongs to internationally renowned ecological priority areas. In a rapid assessment approach, tree species data were collected in Vu Gia Thu Bon (VGTB) Watershed, a river system in Central Vietnam comprising roughly 12,000 km^2. Tree species diversity in VGTB was then modelled using MAXENT. Furthermore, groups of key species with specific functions in the forest ecosystem were selected and based on their distribution models, ecosystem functions associated to biodiversity were mapped. Finally, a map of tree species distribution was constructed for tree species which exhibit multiple of the selected ecosystem functions. The set of tree species distribution maps produced will contribute to the development of conservation measures for VGTB.

O5 - The right kind of diversity or why it still is so difficult to relate diversity to ecosystem functions

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Agricultural intensification leads to a loss of biodiversity (read: species richness) and this relationship is accompanied by a decline in several ecosystem functions and services. What if certain taxonomic groups consistently refuse to act in this way? Is it possible to still identify responses to land-use intensification in these groups by using alternative measures of diversity, or are some groups simply resistant to land-use changes? If alternative measures exist, will it be possible to link these to observed patterns of ecosystem functions and services measured under the same land-use conditions? We use data from comprehensive literature surveys and empirical studies in agricultural systems to show that taxonomic richness is often not a good indicator of land-use intensity in animal communities. In contrast, alternative measures of diversity that preserve information about the identity, the traits or the relatedness of species in communities often reflect land-use types and intensities more precisely. We further show that these approaches may have additional value beyond their quality as land-use indicators, as they relate more directly to soil-related and biocontrol services provided in agricultural systems. Ultimately, we aim for an improved understanding of the responses of communities to land-use changes and the consequences for the provision of important ecosystems functions and services in agricultural landscapes.

Session 9 - Ecosystem Services in aquatic and terrestrial systems

Chair: Aletta Bonn, Brigitte Nixdorf

O1 - Opportunities and limitations for providing ecosystem services in forests through silvicultural management

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The provision of ecosystem services has had a high priority for some time especially in forest ecosystems. Both forest management and forest policy institutions have integrated ecosystem services as a key element of forest policy concepts. But the continuous social debate on the practicability of multi-functional (multi-service) forestry and the integration of various ecosystem services places pressure on the different forest owners. The declaration of multi-functional forest management in general has shown obvious deficits because of differing natural forest conditions and social expectations. Therefore, critical scrutiny of the kind of natural conditions within managed forest that can be used or modified sustainably by forest management to realize particular ecosystem services is needed. Opportunities and limitations can be identified by analyzing traditional and common silvicultural management strategies as instruments for forming tree species compositions, forest structures and tree development stages. The decision about which silvicultural management strategy to adopt based on the opportunities and limitations of each depends on the quantification of relevant environmental factors and forest structures for the different categories of ecosystem services (e.g. provision, regulation and support of forest functions, habitat, culture). The current knowledge on influences of forest structures at different spatial scales and tree species compositions in relation to different forest functions is low. Altogether it is necessary to interpret the consequences of traditional silvicultural management strategies to attain the high quality ecosystem services desired. Thus, the identification of links between forest structures as 'objects' (gaps, tree mixtures, edges) of spatial modification at different spatial scales and the resultant spatial distribution of different qualities and quantities of ecosystem services should be inherent part of future silvicultural research.

O2 - Potential impact of large-scale ecological restoration of river banks on ecosystem services: The River Elbe Example

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The tidal River Elbe is an international waterway feeding Hamburg Port and – together with its floodplains – a unique natural and cultural landscape. To prevent river bank erosion and protect the floodplains, river banks were technically reinforced, mostly by rip-rap. Natural hydrodynamics and biodiversity are severely compromised. Based on Article 6 of the EU-FFH-Directive, an integrated management plan in cooperation of maritime transport and safety, water policy and nature conservation agencies was enacted in 2011 that includes proposals on the ecological restoration of River Elbe banks. In an interdisciplinary study we quantify trade-offs among different ecosystem services as well as between ecosystem services and costs. The first project phase includes an analysis of river bank enforcements, a definition of a prototypical restoration project including a more gently sloping bank, and a survey using qualitative interviews with local citizens (n=21) and stakeholder representatives (n=15) on relevant knowledge and attitudes.

Analyses of high-resolution aerial photographs between Geesthacht Barrage and Otterndorf – excluding Hamburg Port, including islands – identified 330 km of river banks. 45 % are technically reinforced and covered with little vegetation, 13 % are reinforced and covered with some vegetation, and 42 % are at a near-natural state. Rare and protected species such as Bluethroats (*Luscinia svecica*), the German national priority herb Schierlings-Wasserfenchel (*Oenanthe conioides*), and the Stint (*Osmerus eperlanus*), a fish spawning in shallow water, likely profit from restoration.

Ecological and (socio-) economic trade-offs are expected if low-lying grasslands revert to tidal reed beds or alluvial forest. On average, citizens knew only half of the presented species characteristic of the Elbe estuary but still stated substantial appreciation for them. The appearance of pristine river banks was regarded as important for providing recreational services and facilitating ‘landscape aesthetic’ experiences. However, dense riparian vegetation is not appreciated where it blocks the view to the river. Because many reinforced river banks are far from areas used for leisure, our results indicate that carefully sited restoration projects will probably be widely accepted. Stakeholders directly affected financially, such as farmers whose ability to use flood-meadows may be reduced, require compensation in land. The extent of such trade-offs with agricultural provisioning services will be analysed in the next project phase.

O3 - Use of process-based ecosystem modelling for priorisation in ecosystem management, a showcase from the Amazon Basin

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The use of process-based ecosystem modeling has so far been the exception in Ecosystem Service (ES) assessment, although strong advantages have to be assumed, especially when gradual change in ecosystem and thus their provision in ES, e.g. through climate change, have relevance for management decisions.

Here, we demonstrate the added-value of a large-scale process-based ecosystem model to investigate combined impacts of land use and climate change on ES provision. For that we look at the alteration of ES provision in the Amazon Basin. The Amazon Basin is still undergoing deforestation for conversion to agricultural land. At the same time it is facing climate changes with potentially profound alteration of precipitation patterns in some parts. Both processes are assumed to have strong implications on the provision of ES by numerous authors. However, a first quantitative estimation and allocation of these impacts has not yet been published.

The dynamic global vegetation model LPJmL (Sitch et al. 2003, Bondeau et al. 2007) is used to simulate the natural and agricultural ecosystems between 1990 and 2100. For a first phase (1990-2006), we use observed climate and land use data; for a second phase (2006-2050), we use simulated climate data for the SRES scenarios A2 from five global climate models and combine it with land use scenarios (Soares-Filho et al., 2006); and for a third phase (2050-2100), climate change proceeds according to the previously used climate data, but land use is kept constant. Eight ES (global and regional climate regulation, agricultural and timber production, flood regulation, potential for shipping, genetic diversity, and support of indigenous lifestyles) are deduced in post-processing routines incorporating additional data, e.g. accessibility and population distribution.

First results indicate how strongly ES alter under the given scenarios combinations. Whereas some ES are highly sensitive to deforestation, others react mostly on climate change. Spatial patterns of ES alteration differ profoundly over the Amazon Basin with areas encountering either severe deforestation or precipitation change. Although overall agricultural production increases with deforestation, the increasing frequency in droughts in some parts affects agricultural productivity negatively.

O4 - Natural Capital Germany - TEEB DE: Capturing nature's values in Germany

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Natural Capital Germany – TEEB DE is Germany’s contribution to the international TEEB initiative on the Economics of Ecosystems and Biodiversity, focusing on nature's services at the national level. The main task is to produce four topic-based reports presenting the economic case for nature conservation, as a complement to ethical and ecological arguments. The following key policy issues are being addressed:

- What role do ecosystems in Germany play in climate mitigation and adaptation?
- How can we safeguard ecosystem services in rural and protected areas?

- How do urban parks and ecosystems contribute to the quality of life in cities?
- What options and policy instruments are available for better integrating the value of biodiversity and ecosystem services into decision making and planning procedures?

After a short introduction of the aims and approach of TEEB Germany, the presentation will focus on innovative economic instruments as one means to capture nature's values in Germany. What is the role of economic instruments vis-à-vis regulatory approaches in biodiversity and ecosystem service governance? Regulatory approaches such as protected areas are the centrepiece of Germany's efforts towards biodiversity conservation. Often, the opportunity costs attached to setting land aside cause opposition by affected actors and PES are now a common instrument to create conservation incentives for private landowners. However, foregone public revenues caused by conservation policies are so far unduly recognised in fiscal relations between different governmental levels. Ecological fiscal transfers might correct for this and help to foster acceptance of biodiversity conservation among public actors. Furthermore, they may provide necessary financial resources to subnational governments to fully implement and maintain the network of protected areas essential for biodiversity conservation and ecosystem services provision.

O5 - Restoration of regulating ecosystem services in peatlands

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The upland blanket peats of the UK and Ireland are severely degraded with extensive gully erosion and significant investment is underway to restore these landscapes. The negative impacts of peatland degradation on ecosystem services including carbon sequestration and the regulation of water quality and runoff generation have been clearly established. Direct evidence of the benefits of peat restoration for these services has been more limited. Here we review recent data associated with landscape-scale peatland restoration in the Peak District of northern England, where bare peat surfaces have been stabilised by reseeding and the extensive gully networks have been blocked. These measures have transformed the system from a source to a sink of carbon, with the most significant change associated with reductions in particulate organic carbon flux. Data on water quality indicate significant improvements in suspended sediment loads and short-term reductions in water colour, although the latter may be a transient effect associated with restoration treatments and longer term trends have not yet been established. Emerging data on runoff indicate significant post-restoration reductions in peak stormflow and increased lag times, with potential benefits for downstream flood alleviation. Although the topographic legacy of erosion may limit full recovery of these peatlands, the data confirm the multiple benefits of peat restoration for regulating ecosystem services.

O6 - Lakes as sinks for nutrients - photosynthetic assimilation and nitrification as ecosystem services

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Elimination of nutrients is an important ecosystem service in natural and artificial water systems functioning as a self-purification process. Phytoplankton in lakes contributes most to these processes. It is known that phytoplankton primary production is the most important prior condition for nutrient elimination/retention in aquatic ecosystems. In addition to the assimilatory carbon fixation into phytoplankton, biomass nitrification is a relevant process to eliminate nitrogen from the waters. This process takes place in natural aquatic and terrestrial systems, as well as in wastewater treatment plants and ponds. Results of matter turnover in lakes in the Scharmützelsee region are presented concerning spatial and temporal intensity and efficiency of this process across diverse loading phases of the lakes. Phytoplankton and nitrifiers compete for the same substrate (ammonium). We demonstrate the temporal decoupling of photosynthetic production and nitrification in lakes, which is especially obvious in dimictic lakes: Due to the autumnal mixing of hypolimnetic accumulated ammonium, its concentration will increase to an annual maximum during winter. Therefore, nitrification occurs under unfavourable conditions (low temperature, low numbers of nitrifiers in pelagic water). Competition by photosynthetic assimilation of ammonium is negligible. We try to quantify the benefit of the different processes for the ecosystem.

O7 - Trade-offs between ecosystem services in coastal habitats

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Ecosystems of the North Sea and Baltic Sea coast in Europe are sensitive to climate change and sea level rise, with potential feedbacks on future sustainable land use. For instance, natural discharge of surface water into the sea and drainage of coastal lowlands for agricultural land use may become increasingly difficult with rising sea level. Therefore, the ecosystem services provided by alternative land uses and their vegetation need to be predicted to enable informed decisions about future land uses. However, multiple ecosystem services are not additive, but organized in trade-offs. Here we show how these trade-offs depend on components of the environment, functional plant ecology and ecosystem functions.

Our study included 4 different coastal regions (Baltic Sea and North Sea of Germany, Denmark and The Netherlands), ranging from salt marshes to reeds and grassland managed for agricultural use. We sampled 200 plots, collecting data on environmental properties, land management, plant functional traits, ecosystem functions and ecosystem services.

We found clear trade-offs between provision and regulation services which are however mediated by soil resource availability, non-consumable environmental factors such as salt, and human disturbance intensity.

Our results suggest that trade-offs between provision and regulation services are contextual and take different directions when land management is changed.

O8 - The trade-off of ecosystem services in a Danubian riparian forest

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Organic carbon (C) sequestration and sediment trapping in riparian forests provide crucial ecosystem services. Because of their location between aquatic and terrestrial ecosystems, riparian forests are highly dynamic and complex ecosystems in space and time. Additionally, many of these ecosystems are altered by water engineering measures such as dike construction. However, our knowledge on the interplay of environmental parameters, dike construction and the linkage of sediment trapping and C sequestration is very limited. This study (1) quantified C sequestration by sedimentation and longer term soil C stocks (0-1 m) using dendrogeomorphological methods, (2) modeled the relative influence of environmental parameters and dike construction using boosted regression trees, and (3) determined the linkage between sedimentation and C sequestration in the Donau-Auen National Park, Austria. Mean sedimentation rate and C sequestration of the total riparian forest were 0.8 cm yr^{-1} and 3.3 t C ha^{-1} yr^{-1} with significantly higher values in flooded riparian forest (FRF) compared to diked riparian forests (DRF). In contrast, longer term C stocks (238 t C ha^{-1}) were significantly higher in diked riparian forest whereby C stocks of the whole riparian forest were inversely related to C sequestration. Tree species, fluctuation of groundwater table, and the distance to the river were influential parameters in C sequestration models. Moreover, soil C stock was positively correlated with C concentration and distance to the river and inversely correlated to sedimentation. Our results showed that C sequestration and sedimentation are closely linked as each of them responded similarly to roughly the same environmental parameters. The inverse response of C sequestration to C stocks points to different stabilization processes of allochthonous and autochthonous C after sedimentation. Because dike construction was ruled out as significant predictor variable, differences between FRF and DRF can not be attributed directly to the dike - at least at given distance to the Danube River and the considered time horizon of 50 years.

O9 - Carbon stocks and regeneration of Caatinga vegetation along a gradient of grazing intensity and water availability in NE Brazil

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Most dry forests in the world are threatened by overgrazing and subsequent desertification which also applies to Caatinga vegetation in NE Brazil. Therefore sustainable land use strategies are urgently needed for maintaining biodiversity and fundamental ecosystem services such as carbon storage and biomass production. In this study we assessed the regeneration as well as carbon stocks in aboveground biomass in 40 study plots along a grazing and water gradient at the Itaparica Reservoir, Pernambuco, Brazil. These studies are part of the BMBF funded INNOVATE project which aims to develop innovative, sustainable land use strategies which may also include the current grazing regime (goats, donkeys and cattle).

Sampling sites with a high water availability show significantly higher carbon stocks (69.2t biomass ha^{-1}) than those having only intermediate or low water availability (57.3t biomass / ha^{-1}, 44.3 t biomass ha^{-1}, respectively). On the other side grazing intensity does not exhibit a significant effect on carbon stocks. Accordingly, the population structure of relevant tree species of the study area was characterized by a J-shaped diameter distribution with most individuals in the smallest stem diameter class (<10 cm), irrespective of grazing. Neither grazing nor water availability affected the number of tree saplings. Our data implies that grazing at the given intensity (< 8 animals ha^{-1}) does not lead to detrimental effects on tree cover in the study area and may thus be a component of sustainable land management in semiarid north eastern Brazil. To obtain more insight concerning other plant functional groups subsequent analyses will follow.

O10 - Value of natural floodplains for water quality and quantity regulation

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Floodplains subject to regular inundation are multifunctional ecosystems that provide a variety of ecosystem services (ESS), directly or indirectly contributing to human welfare. These ESS comprise, for example, flood control (as a regulatory function), water purification due to nutrient retention (as a filter function) or recreational opportunities (as a cultural function). Furthermore they support high levels of biodiversity. However, a serious loss and increasing degradation of floodplain ecosystems can be regarded worldwide; in Germany, for example, only about 10-20% of the original floodplains are still connected to the stream along large rivers. It is widely acknowledged that the public goods character of many ESS accounts for an undervaluation in management decisions. This is largely caused by the lack of information on the value of these benefits. The aim of an economic valuation is to provide such information on the benefits of functional ecosystems for human welfare and by doing this, to enhance the public perception of ESS. Furthermore, the valuation of positive and negative environmental effects associated with management options contribute to an increased efficiency of policy-making. The economic value of ESS has become an important concept on political agendas, as the international TEEB study and subsequent national initiatives suggest, and has been integrated in the requirements of recent European directives for water policy-making (WFD, MSFD). This contribution addresses the issue of the economic value of natural floodplains. The aim is to give an insight into the economic perspective on ESS and suitable approaches for estimating the value. An overview of recent valuation studies of the benefits of aquatic ecosystems is given, focusing on the effects on water quality and quantity regulation, based on different approaches to assign monetary values. The challenges of an economic valuation are discussed: the assessment of the bio-physical effects as a prerequisite for an economic valuation, and the integration into the political and administrative decision-making the give ESS more weight in environmental decision-making.

O11 - Assessment of ecosystem services in floodplains - case study Germany

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Floodplains are among the most valuable, but also some of the most endangered ecosystems in Europe. They are hotspots of biodiversity and central elements of an ecological network. There are only a few ecosystems that offer such a remarkable variety of goods and services to humans such as rivers and their floodplains (e.g. in terms of flood prevention, ground water reservoirs, filters for sediment and dissolved nutrients and pollutants (sink function), carbon storage, recreational areas or natural habitats). Floodplains can only provide these ecosystem services however, if their ecological integrity is sustained.

Based on a first nationwide, consistent and updatable inventory of the loss and status of German floodplains providing an overview of former and active floodplains in Germany (Status report of

German floodplains by the German Federal Agency for Nature Conservation), we developed methods to quantify and assess floodplain functions and services for large rivers.

In particular, four ecosystem functions and related services were studied:

- flood retention
- nutrient retention (nitrate retention through denitrification and phosphorus retention through sedimentation
- carbon stocks and carbon sinks in terms of greenhouse gas emissions
- habitat function /biodiversity

Economic aspects were included (e.g. mitigation costs). This talk will focus on methods and results for the assessment from available spatial information on land use and soil types as well as related proxies for 79 floodplains across Germany.

O12 - Ecosystem services, ecosystem functions or natural state - How to deal with exemptions under the Water Framework Directive?

Christine Wolf[1]

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The Water Framework Directive (2000/60/EG) is an ambitious step towards an integrated water resource management. Its goal is to reach at least a so-called *good ecological and chemical status* of all European surface and groundwater bodies until 2015. An extension of deadlines is possible until 2027.

In Germany, presumably, 82% of the surface waters and 36% of the groundwater bodies will not reach the *good status* until 2015 and in the long run, an exemption rate of 50% has been forecasted.

Foremost, reference conditions of undisturbed aquatic ecosystems without anthropogenic pressures (natural state) had to be defined. Subsequently, a *good ecological status* had to be derived admitting slight anthropogenic changes. This approach is based on the assumptions that nature has an intrinsic value irrespective of human use and that an aquatic ecosystem in its natural state is (*properly*) functioning.

Since European water bodies have been heavily used and transformed during the centuries, the WFD concedes stronger anthropogenic alterations in the case of artificial/heavily modified water bodies and develops a regime for exemptions. However, whereas the reference conditions for the natural state had to be identified, reference conditions for the so-called *good ecological potential* of artificial/heavily modified water bodies and the *highest ecological and chemical status possible* for exemptions were not developed.

The presentation will discuss pros and cons of three different approaches towards the elaboration of these reference conditions: First of all, an ecosystem services approach, which derives priorities of conservation in function of desired and (potentially) delivered services. Secondly, a functional approach, focusing on functional substitutions instead of a fixed community composition in order to achieve a *functioning* ecosystem delivering certain services. Finally, an approach of a modified natural state, which strives to combine human demands and natural state.

O13 - Principal gradients in the literature on ecosystem services and conservation

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Scientific publications both on ecosystem services and conservation ecology increased exponentially in recent years, making an overview of the current literature challenging. Quantitative reviews covering either broad or specific topics are often at hand, yet are potentially biased by selection process and data evaluation.

We propose a new method to review available literature based on a multivariate full text analysis. We derived a relative abundance matrix for a subset of relevant words, which was then analyzed using ordinations. Groupings within the literature were confirmed using indicator analysis, as derived from classification based on wards clustering. Our analysis revealed principal gradients within the literature, and allowed partial quantification of the isolation of different and more specific sub-communities within ecosystem service as well as conservation research. While part of the ecosystem services literature is focused on economics, the other end of the principal gradient investigates mainly ecological dynamics. Connections between these ends are rather weak, yet some topics such as governance and conservation offer vital links within the overall research. The literature fails to sufficiently engage with many of the normative concepts inherent in the ecosystem services and conservation research agendas.

We suggest that our approach may aid quantitative reviews by letting the relative abundance of words guide a better understanding of the principal gradients within the literature. This does not only add a new approach to understand complex emerging topics within ecosystem service research and conservation ecology, complementary to existing approaches. Furthermore our procedure enables quantitative reviews and meta-analysis to move beyond subjective reviewing procedures, thus letting the words of the literature speak for themselves.

P1 - Ecosystem service of European bats in an anthropogenic landscape

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Bats are known to provide important ecosystem services like the distribution of seeds, the pollination of tropical plants and the consumption of insects (reviewed in Ghanem & Voigt 2012). In the temperate zone, bats are particularly relevant for humans by feeding on pest insects, thus reducing insect populations that are detrimental for agriculture (reviewed in Kunz et al. 2011).

In this study we investigate species richness and foraging activity of bats on three crop types (corn, rapeseed and wheat) in an intensively used agricultural area in the North of Germany. Additionally we assess if and how factors like the crop type, the relative insect abundance and the landscape structure have an effect on bat activity and species richness. Using a genetic approach, we investigate the diet of two common aerial-hawking bat species. We aim to estimate the extent of ecosystem services provided by European bat species and are specifically interested in answering the question whether they feed on economically relevant pest insects, and whether this translates into a monetary benefit for the agricultural industry.

This study is embedded in a large-scale project (AgroScapeLabs: www.scapelabs.org) which aims at exploring land use effects on biodiversity and its links to ecosystem functioning in an agriculturally used landscape.

P2 - Ecosystem service valuation for implementing the European Marine Strategy Framework Directive

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Human well-being highly relies on healthy (marine) ecosystems and their capacity to provide ecosystem services (e.g. fish and other sea food, climate regulation, moderation of storm floods or tsunamis, habitat for (commercially used) species and opportunities for recreation). However, the world's oceans and coastal ecosystems are currently severely threatened and continue degrading facing impacts by multiple marine sectors as fisheries, aquaculture, shipping, energy (oil, gas and renewable) and tourism. Global marine policies are adopting the ecosystem approach in order to achieve the improvement, restoration, or protection of coastal and marine ecosystems and their resources.

An example of this type of legislation is the European Union's (EU) Marine Strategy Framework Directive (MSFD), developed as the ecological arm of the EU Maritime Policy. The MSFD asks to achieve a good environmental status in European regional seas by 2020. For doing so, the directive requires the application of the ecosystem approach to manage human activities in order to mitigate not only single-sector but also collective pressures and ensure sustainable use levels. One central aspect of the ecosystem approach is to take into consideration the value of the whole bundle of ecosystem services (ESs) and the trade-offs which may occur when implementing different management options for decision making.

The on-going FP7 project ODEMM (Options for Delivering Ecosystem-based Marine Management, http://www.liv.ac.uk/odemm/) is aiming to provide scientific background for implementing the MSFD: different sustainable management options are developed and are compared, based among others, on the costs and benefits related to the change of ES provision under the different management options.

This poster will present the approach ODEMM has taken to assess and value ESs in the context of MSFD implementation. It will also focus on obstacles ODEMM experienced regarding marine ES assessments and ecosystem-based marine management and will explore possible solutions to deal with those obstacles.

P3 - Multiple factors influence the role of arbuscular mycorrhizal fungi in soil aggregation - a meta-analysis

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Soil aggregation is a crucial aspect of ecosystem functioning in terrestrial ecosystems. Arbuscular mycorrhizal fungi (AMF) play a key role in soil aggregate formation and stabilization. Here we quantitatively analyzed the importance of experimental settings and biotic and abiotic factors for the effectiveness of AMF to stabilize soil macroaggregates.

We tested 13 predictor variables for their relevance with a boosted regression tree analysis and performed a meta-analysis, fitting individual random effects models for each variable.

The overall mean effect of inoculation with AMF on soil aggregation was positive and predictor variable means were all in the range of beneficial effects. Pot studies and studies with sterilized sandy soil, near neutral soil pH, a pot size smaller than 2.5 kg and a duration between 2.2 and 5 months were more likely to result in stronger effects of AMF on soil aggregation than experiments in the field, with non-sterilized or fine textured soil or an acidic pH. The extent to which AMF promote soil aggregation seems to be independent of the number of species present in the system, host plant identity or soil organic carbon content and the experimental outcome was insensitive to laboratory procedures.

P4 - Dynamics of the Coastal Karst Aquifer in Northern Yucatán Peninsula

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The Yucatán Peninsula lacks surface waters consequently groundwater resources are indispensable for human water supply. Due to the high recharge rate of the shallow karst aquifer, most of the Yucatán Peninsula does not face a problem related to water scarcity but water quality, one of the most important ecosystem services. Groundwater that underlies the city of Mérida discharges at the coastline and several points and diffuse anthropogenic and natural (saltwater intrusion) contamination sources compromise water quality. The main objective of this research was to characterize the current status of a 1600 km^2 area of the coastal Yucatán karst aquifer in the northwestern region of the Yucatán Peninsula, including both quantity and quality issues by investigation of hydraulic conditions and the hydrochemical water composition. This information was used to understand the systems' dynamics and its importance for the diverse ecosystems in the karst terrain. Because of the climatic conditions and high hydraulic conductivity of the geologic material natural recharge is very dynamic, a direct relationship between precipitation and groundwater head evolution in the monitoring wells was identified. The spatial and temporal variations of water quality were determined. Natural discharge at the coastal zone was investigated from flowing artesian wells; influence of tidal fluctuations, natural and induced recharge by precipitation and planned and unplanned injection was identified. The results were used to develop a conceptual model that describes the functioning of the aquifer flow system as a fundamental component and driving force of aquatic and terrestrial ecosystems and shows the indispensable need of preservation and sustainable management of the study area.

P5 - Presence of four secondary endosymbionts in cereal aphids and mummies

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In this study we investigated the presence of the four endosymbionts *Hamiltonella defensa*, *Serratia symbiotica*, *Regiella insecticola* and the so-called x-type in the three cereal aphid species *Sitobion avenae* F., *Metopolophium dirhodum* Walker and *Rhopalosiphum padi* (L.). These facultative endosymbionts are supposed to protect aphids at least to some extent from e.g. parasitation (mainly *H. defensa* together with the phage *AP*SE), heat (*S. symbiotica*) and *Pandora neoaphidis* (*R. insecticola*) (1; 2) and can be therefore of interest for biological control of aphids.

We sampled aphids and mummies in wheat fields and screened them for secondary endosymbionts with multiplex PCR targeting the four species with species-specific primers.

Preliminary results show that the occurrence of secondary endosymbionts in the three aphid species seems to differ with higher percentages of *S. avenae* and *M. dirhodum* harbouring endosymbionts than *R. padi*. Most abundant was *H. defensa* in *M. dirhodum* and *R. insecticola* in *S. avenae*. *S. symbiotica* and X-type were detected less frequently than the other two bacterial species. The numbers of mummies with secondary endosymbionts was high (ca. 50 %) in both mummified *S. avenae* and *M. dirhodum* which were parasitized by *Aphidius* spp. and *Praon* spp.

In another study, *H. defensa* was detected in field-collected *M. dirhodum* as well and it was assumed that a high percentage of this aphid species may harbour this endosymbiont (3). In *S. avenae*, *H. defensa* and *R. insecticola* were found before in the UK, whereas *S. symbiotica* or X-type were not detected (4).

It was shown that parasitoids can develop and hatch from aphids that contain *H. defensa* and other defensive endosymbionts (5) and that they can adapt to the endosymbionts after some generations (6). However, parasitoids emerging from aphids with defensive endosymbionts have a reduced fitness (7). The current results suggest that parasitoids might partly overcome the protection conferred by these bacteria in the field as we collected aphid mummies infected with *H. defensa* and other secondary endosymbionts.

1 Guay et al. J Insect Physiol 2009
2 Burke et al. Appl & Environ Microbiol 2009
3 Telesnicki et al. Rev Argent Microbiol 2012
4 Lukasik et al. Ecol Entomol 2011
5 Bilodeau et al. Evol Ecol 2013
6 Dion et al. J Evol Biol 2011
7 Schmid et al. Funct Ecol 2011

P6 - Don't ask don't tell - the radioactive impact on provisioning ecosystem services after nuclear accidents

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Purpose We address the impact on provisioning ecosystem services caused by radiocesium 137 contaminations after nuclear accidents. We collated Cs-137 measurements to spatially illustrate the known impacts and offer a critical perspective on the use of maximum allowed thresholds for the consumption of food and fodder.

Design/Methodology Based on an initial exploratory analysis of approximately 3000 peer-reviewed articles related to Three Mile Island, Chernobyl and Fukushima, we identified 123 papers which measured increased Cs-137 levels in food, fodder and wood. Based on these 123 papers a standardized review-protocol was used to map and quantify the known impacts of nuclear accidents on provisioning ecosystem services.

Findings Coherent spatial mapping of the impacts on provisioning ecosystem services requires: (1) the need for an increase on the use and availability of monitoring data as well as an increase in publications of studies covering ten and more years. (2) Research studies need to follow a coherent protocol enabling common information on sampling location and identification of the use or nonuse of the related provisioning ecosystem service. (3) A critical dialog on the impacts of nuclear accidents on human well-being if the maximum allowed thresholds for the consumption of food and fodder levels were implemented. Further we recommend a common use of terms of provisioning ecosystem services within such threshold schemes.

Practical implications Our analysis illustrates different challenges quantifying the impacts of nuclear accidents on provisioning ecosystem services. Decision-makers have to be aware of this uncertainty if they decide to use nuclear power generation in their energy mix.

Originality/value To the best of our knowledge our work presents the first detailed analysis of the radiation impact of nuclear accidents on provisioning ecosystem services. Thus, we contribute to the evolving debate on global decision-making towards sustainable energy transitions.

Session 10 - Eco-evolutionary changes in aquatic and terrestrial systems

Chairs: Ralph Tollrian, Ralph Tiedemann

O1 - Why rapid adaptive evolution matters

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It is increasingly apparent that evolutionary dynamics that act on the same time scale as ecological processes might play an important role in determining population, community and ecosystem dynamics. I will present results of an algae-rotifer system showing that changes in adaptive genetic variance in a defense trait of a prey population can radically alter eco-evolutionary dynamics. The results show that not only community dynamics are altered by the initial amount of genetic variation but also whether or not genetic variation is lost or maintained. I further explore how higher food web and spatial complexity affects the potential for eco-evolutionary dynamics.

O3 - Comparison of plasticity of developmental traits among matrilines in a wild population of the common frog

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Adaptive phenotypic plasticity is a key mechanism to cope with changing environments, since it allows organisms to exploit a wider range of habitats. Studies often focus on divergence of plasticity between populations, however, differences in phenotypes and life-history traits within populations are often neglected. In our study, we focus on differences in life history traits within a wild population of the common frog (*Rana temporaria*) in Germany. This population reveals pronounced differences (up to factor ten) in metamorphic traits (development time, size and weight at metamorphosis) both within and between emigrating frog cohorts on very small geographic scale. These traits could not be related to commonly assumed influencing parameters such as predation, intra-specific competition or environmental pond characteristics. In order to investigate the potential genetic influence on the observed differences, we used microsatellite analysis to assign tadpoles and emigrating juveniles into kin-groups based on their multilocus genotypes. We assessed differences in number, timing and size of emigrating froglets among matrilines. To this end, DNA samples of 81 egg clutches and 777 emigrating froglets of one study pond were analysed. Individual matrilines differed distinctly in their developmental success with five matrilinies having more than

20 froglets leaving the pond while most matrilines had only very few offspring developing successfully to metamorphs. Furthermore, matrilines with high number of metamorphs showed shorter development times than matrilines with only 2 -3 emigrating juveniles. Our results strongly indicate that even on very small geographic scale, differences in developmental traits are not only affected by environment, but also genetic background is an important issue in shaping life history traits within natural populations.

O4 - The evolution of pollinator emergence timing: modeling the influence of environmental variance, intraspecific competition, and longevity

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The timing of interannual phenologies like flowering in plants or emergence in insects fundamentally affects the fitness of individuals. Particularly in times of globally changing climatic conditions a deeper understanding of the evolutionary mechanisms shaping phenologies is a prerequisite for scientifically based risk assessment. We analyze the evolution of emergence timing in a population of pollinators. Specifically, we are interested in the influence of longevity, intra-specific competition, and inter-annual fluctuations in season length on the temporal distribution of emergence. In our model we assume that individual phenotypes are characterized by a time of emergence that is under stabilizing selection with respect to an optimal value that fluctuates between years. At the genotypic level individuals are characterized by their offspring distribution with heritable genetic variation for the mean and variance. We use an analytical model and individual-based simulations to show that for short lived organisms intraspecific competition promotes an ideal free distribution of emergence times whereas bet-hedging in a variable environment can lead both to diverse phenotypes due to risk spreading and to a small range of phenotypes by risk-avoiding strategies. The different selective forces thus lead to a compromise between synchronising with the environment and increasing the variability in timing, dependent of the external circumstances and stimuli. It is particularly interesting to note that the observed evolution of genetically distinct emergence times may cause assortative mating and form a basis for sympatric speciation.

O5 - Effects of different light environments on epigenetic variation in populations of Viola elatior

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Epigenetic information, such as DNA methylation, are often inherited in plant species and could modulate gene expression without changing the primary nucleotide sequence. Unlike random DNA

mutations, epigenetic modifications might be directly influenced by biotic or abiotic factors, making them an important molecular process to cope with unpredictable and changing environments. *Viola elatior* is a rare floodplain species that in Europe is restricted to large river corridors. It occurs along a successional gradient in a range of dynamic, alluvial habitats, covering floodplain meadows, ecotones and woodland fringes. These habitats are characterized by strong differences in light availability, from completely sunny to very shady conditions. Due to disturbance events or succession each habitat type could develop from one type into another within relatively short periods of time.

The aim of this work was to find out how DNA-methylation patterns are distributed among populations of *Viola elatior* in contrasting habitat types and if there are potentially adaptive changes that are related to light availability. We therefore assessed genetic and epigenetic variation of different meadow- and woodland-populations by using amplified fragment length polymorphism (AFLP) and methylation sensitive amplified polymorphism (MSAP) analysis. The results are discussed in relation to the adaptive impact of epigenetic processes under environmental changes.

O6 - Eco-evolutionary changes in aquatic and terrestrial systems

Macroevolution and microevolution together control the ecological performance of individual oak trees

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The ecological performance of an individual may depend on both macroevolutionary distinctness of its neighbors and microevolutionary distinctness of its alleles: phylogenetically distant neighbors reduce exchange of enemies or mutualists, heterozygous alleles may affect the individual’s response to these enemies and mutualists. Moreover, the performance of heterozygote individuals might depend on the phylogenetic proximity of neighbors and vice versa.

We studied oak individuals (of the hybridizing species *Quercus petraea* and *Q. robur*) in neighborhoods of 10 to 130 million years distance. We considered performance both in terms physiology, species interactions and ecosystem functioning for decomposition. Physiological performance reflected by leaf nitrogen contents deceased with phylogenetic distance of neighbors and heterozygosity of individuals, but the former compensated for the effect of the latter. C/N ratios and branch growth showed the inverse pattern. Budburst phenologies were delayed due to phylogenetic distant neighbors, reflecting a tendency of later budburst of heterozygous individuals in phylogenetically distant neighborhoods. Interaction performance reflected by high phytophagy levels independently decreased with the phylogenetic distance of neighbors or heterozygosity of individuals. Phylogenetic distance increased activity of multiple mycorrhizal enzymes, reflecting a tendency of higher activity of heterozygous individuals in phylogenetically distant neighborhoods. Ecosystem performance as reflected by litter thickness independently increased with phylogenetic distance of neighbors and heterozygosity of individuals. Multiple other parameters remained unchanged.

Such performances are likely to feedback on the fitness of the oaks, possibly selecting for or against the underlying processes, including niche convergence, outbreeding, or particular combinations thereof.

O7 - Impact of elevated temperature on the gene expression of tapeworm parasitized three-spined sticklebacks

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In aquatic environments, poikilotherm species and their interaction are expected to be significantly affected by global warming, as vital functions are determined by ambient temperature. To explore how a host specific tapeworm parasite influences metabolism and immune activity of a teleost host in a scenario of elevated temperature, individuals of the three-spined stickleback infected by Schistocephalus solidus, defeat-competent individuals, and naïve sticklebacks were tested for differences in their livers' gene expression through RNA sequencing after 50 days of exposure to 13°C and 24°C, respectively. In all treatment groups the higher temperature affected both higher metabolic rates and energy generation, whereat the naïve sticklebacks were less afflicted by temperature than the infected and the defeat-competent sticklebacks, in which strong differences were found with amongst others, upregulated heat shock protein expression as cellular stress reaction to elevated temperature. Exclusively in infected sticklebacks the immune activity was down-regulated at 24°C. Hence, elevated temperature amplifies the parasite impact on the stickleback host, even if the parasite is defeated. The combination of the factors temperature and parasitation most likely puts selective pressure on the host, by which alterations of genotype frequencies in stickleback populations, and subsequently to aquatic system properties may be entailed.

O8 - Effects of Zn and Cd hyperaccumulation on preferences and performance of different herbivores

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Some metal tolerant plants are able to accumulate extraordinary high levels of metals in their above-ground tissues. These so-termed hyperaccumulators can be found on ultramafic but also on non-contaminated soils. The elevated metal concentrations may protect the plants against certain herbivores and pathogenic agents, as suggested by the elemental defense hypothesis. We investigated the effects of Zn and Cd that are hyperaccumulated by *Arabidopsis halleri* (Brassicaceae) on the preference behaviour of different feeding-specialists of Brassicaceae, including a potentially adapted field-collected population of *Pieris napi*(Lepidoptera: Pieridae) and laboratory colonies of *Athalia rosae* (Hymenoptera: Tenthredinidae) and *Phaedon cochleariae* (Coleoptera: Chrysomelidae). As test diets we used a wild population of *A. halleri* grown on different soils, a transgenic line that exhibits reduced metal accumulation as well as leaves of the non-accumulator *Brassica rapa* treated with different metal concentrations. Furthermore, the concentration-dependent effects of metals on survival of a generalist herbivore, *Heliothis virescens* (Lepidoptera: Noctuidae), were determined using artificial diet amended with different Cd and Zn concentrations offered alone and in combination. The metals had deterrent effects on feeding by specialists, but we observed no effects on oviposition behaviour, tested in *A. rosae*. The performance of the generalist was negatively impaired by each metal at higher concentrations, but the combination of metals decreased the survival of the generalist already at lower concentrations due to additive effects. We can summarize that deterrent and toxic effects of metals play a key role in defence against herbivores and that joined metal effects may be particularly important in the evolution of hyperaccumulation in plants.

P1 - Plasticity in traits and its effects on population dynamics

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Biodiversity greatly influences the potential of ecological systems to buffer changes in the environment and it depends – besides the genetic and species diversity of the system – also on the phenotypic diversity. Phenotypic plasticity in functional traits (e.g. morphological defense of prey) gives the opportunity of rapid adjustment to changing conditions and leads to a fitness

improvement under fluctuating environmental conditions. Even though this plasticity in traits is a key property for the understanding of population dynamics, empirical data on traits of individuals or populations changing over time is still scarce.

Analyzing the abundance and trait values of selected bacterial strains under variable grazing pressure of the planktonic predator *Ochromonas danica* we focus on the questions if the adjustment potential of prey increases with phenotypic plasticity and if the initial trait-plasticity influences the population dynamics. With an automated measurement system we are able to generate highly resolved time series of population dynamics of the bacterial prey strains and the protozoan predator in continuous chemostat cultures.

We found empirical evidence for a trade-off between the growth rate and morphology of prey bacteria which could possibly be used for mechanistical explanations of the observed behavior.

P2 - Edibility of different bacteria strains by *Ochromonas danica* depending on morphotypes and grazing adaptations of these bacteria

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As a result of anthropogenic influences the biodiversity is declining worldwide which reduces the ability of ecosystems to tolerate environmental changes leading to an increasing interest of scientists in this relationship. The range of selectivity of a predator and the ability of a prey to reduce its edibility while a grazer is present can be considered as an important feature of biodiversity, which may greatly affect trophic interactions and thus food web dynamics. Knowledge of organismic trait variability, for example the range across which cell size may change, provides valuable information about how effective the organism can deal with given environmental changes.

The focus of this study is on grazing experiments with *Ochromonas danica* and different bacterial strains to test for **a)** a connection between the predator's ingestion rates and the size of bacteria, and **b)** that bacterial strains with a high morphological plasticity suffer less from predation than bacteria with a lower phenotypic plasticity. In the presence of a grazer, the diverse edibility of bacteria, which can be explained by differences in the costs for defense, leads to coexistence of different strains of bacteria and finally to a higher biodiversity. Thus differences in trait variability have the potential to increase biodiversity and hence ecosystem resilience.

P3 - Population genetic patterns of the river corridor plant *Cnidium dubium* in fragmented river landscapes

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Cnidium dubium is a threatened herbaceous plant species confined to river corridors in Central Europe. At the Elbe River, the species is distributed over more than 400 river kilometres with equal occurrences in the active floodplain (still inundated in times of high water) and the inactive floodplain (not flooded anymore due to the construction of dykes). We assumed that hydrochory as well as disturbance processes are major factors shaping plant genetic patterns in dynamic river landscapes and therefore we expected differences between both floodplain compartments. For this study, about 800 individual samples in 50 patches along the whole Elbe distribution area were genotyped with nuclear microsatellite markers. First results show differences in clonal and genetic diversity among patches/groups of patches which could neither be related to the floodplain compartment nor the longitudinal course of the river which could be a hint that other factors (such as land use) might be responsible for shaping the observed patterns. The overall high level of clonality indicates a low level of reproduction by seeds.

Session 11 - Response and adaptation of forest ecosystems to climate change

Chairs: Andreas Bolte, Christian Ammer, Peter Spathelf

O1 - Modelling plant ecosystems over the coming century : results of ISI-MIP

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The terrestrial carbon sink is a large source of uncertainty in current predictions of future climate change. Dynamic Global Vegetation Models (DGVMs) are our main tools for understanding the impacts of the climate on Earth's ecosystem as well as the resulting feedbacks, but they are highly variable in their design and behaviour, especially in regard to plant diversity.

Seven global vegetation models including four DGVMs were run for the 1971-2099 period using daily climate data from five global circulation models under four greenhouse gas concentration scenarios for the Intersectoral Impacts Model Intercomparison Project (ISI-MIP), an initiative that aims to provide fast-track global impact assessments for the IPCC's Fifth Assessment Report. All simulations showed an increase in global vegetation carbon over the twenty-first century but with large variation between models and in their spatial patterns. Most models showed very similar linear relationships between NPP and global land surface temperature change and different but still linear relationships between the residence time of carbon in the vegetation and land surface temperature change. Two that did not predicted a decrease in vegetation carbon above 6 °C land warming, caused by a decrease in NPP in one case and in carbon residence time in the other. Both global decreases coincided with specific biome shifts in places such as the Amazon region and northern Eurasia as moisture stress and high temperatures respectively caused one plant type to die off and be replaced.

O2 - Medium-term productivity changes for 8 temperate and Mediterranean species in France depend on the climatic context

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There is compelling evidence that forest productivity has changed over the XXth century due to environmental changes. However consistent comparisons of species reaction to environmental changes at the scale of the forest resource are still lacking.

Our goal was to assess recent changes in forest productivity at a national scale in France for 8 species of contrasted ecological niches and distributions (temperate, mountain and Mediterranean species) based on the French National Forest Inventory data. We modeled stand basal area increment (BAI) as a function of stand stocking, developmental stage and site fertility, and we further added an effect of calendar date to estimate historical productivity changes for each species.

As a main result, we highlighted the species-specificity of recent BAI changes, spanning from -17% to +42 % between 1982 and 2005. Although many species depicted an increase in productivity between the years 80s and the 90s, the trends diverged in more recent years displaying either an acceleration (*P abies*) a stagnation (*A alba*) or a decline (*F sylvatica*, *Q petraea*, *P halepensis*). No significant trend was found for *P sylvestris* and *Q robur*, and *Q pubescens* productivity declined continuously over the period considered. Besides we identified an effect of 2003 drought on all species productivity. Interestingly the level of BAI change was related to broad climatic contexts: productivity strongly increased for mountain species and declined for Mediterranean species, whereas it depicted very moderate (positive or negative) or no trends for lowland species.

This work provided the first national-scale assessment of recent productivity changes in France for a wide range of species and highlighted the species specificity and context dependence of these changes, thus preventing to generalize species behavior in the context of climate warming.

O3 - Projections of forest landscapes based on forest inventories, climate-sensitive impact models and growth simulations

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We present projections of forest landscape development in German state of Baden-Württemberg. The growth simulator BWinPro is therefore applied to comprehensive data from regional forest inventories. BWinPro is enhanced by climate-sensitive impact models in order to quantify the effect of climate change on growth and mortality of forest trees. Site index was modeled using forest inventory data and geoadditive regression models. Parametric frailty models were applied to describe tree mortality on long-term sample plots. Both models were parameterized with retrospective climate data and were then applied to REMO-projections of IPCC-SRES scenarios.

O4 - European species distribution models as a basis for forest management planning under climate change in Bavaria: a new digital tool for practitioners

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European forests respond to increasing mean temperatures and severe droughts already today with changed growth regimes, in some extreme situations even with forest dieback. Additionally, the pressure on trees by outbreaks of forest pests is increasing with higher temperatures in dry years or due to mild winters. So all in all, the mortality risk is increasing for stands that are already at the warm-dry distribution limit. In Bavaria this affects e.g. Norway spruce (*Picea abies* [L.] Karst.) which is the most frequent tree species. The natural European distribution of spruce can be divided into three major regions due to postglacial re-colonization (Nordic-Baltic-Russian, the Hercyno-Carpathian and Alpine regions), but it has been planted in Bavaria and other parts of Europe in forestry outside this cold northern or mountainous regions and these stands are vulnerable under climate change. Due to the predicted temperature rise until the end of the century, forestry has to stabilize (and therefore adapt) these vulnerable stands. Conversion into stable mixed stands is one important way among others like e.g. short rotation times or thinning in order to reduce transpiration. Here, a tool to describe the vulnerability of tree species is presented which bases upon species distribution models (SDMs). SDMs are a way to describe the relation between environment and species distribution with correlative techniques like regression models. They can be used to predict species distribution under a changed climate (e.g. with climate data modeled upon the boundary assumptions of SRES scenarios). In this study European and Bavarian data are used to calibrate species distribution data under current environmental conditions. With the help of digital climate and soil data all over Bavaria, the species distribution models are calculated for the whole state. The resulting risk maps are a tool for forest management decisions and are part of a digital forest information system. Additionally, the European models are developed further in order to handle climate ensemble data and to specify uncertainty due to differences of global and regional circulation models.

O5 - Do trees sequestrate more biomass as they grow faster? An analysis of past growth and wood density trends of Norway spruce in the Vosges Mountains

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How biomass sequestration of forest ecosystems is affected by environmental changes is an issue of increasing concern. Recent investigations on the mean ring density of Norway spruce in the Vosges Mountains (France) have demonstrated a decrease by -20 kg/m^3 over the 20th century (-5%). In addition, mean ring density was shown to exhibit a negative relationship with ring width, as usually observed on coniferous trees. This suggests an even more acute historical decrease in ring density, in the prevailing context of past increased forest growth over Europe.

In order to draw an integrated assessment of biomass sequestration evolution over time, we investigated past primary and secondary growth (diameter at 1.30m) trends of Norway spruce over the same sites. A statistical modelling approach of annual stem analysis and tree-ring measurement data was developed to separate these centennial historical signals from the effects of developmental stage and site fertility. Trends in mean ring density, height and radial growth were then combined using a total aboveground volume equation valid for Norway spruce, to identify possible trends in annual sequestration of wood biomass.

Height growth strongly increased (+50%) over the past century and accelerated in the 1950s. A very similar chronology was evidenced for radial growth, though of a higher magnitude (+70%). The strong acceleration in growth was found synchronous to the sharpest decrease in ring density. Given the negative ring size – density relationship, the radial growth increase caused an additional -20 to -30 kg/m^3 in ring density, leading to a total -50 to -60 kg/m3 over the past century (-14%), depending on site fertility. At constant diameter and height, the annual tree aboveground volume increment was shown to increase by 25%. Consequently, the annual tree biomass increment increased by only +7 to +9%.

Hence, Norway spruce in the Vosges Mountains has experienced a strong growth increase but the evidenced decrease in ring density was further accentuated by increased growth, and reached a significant magnitude. As a major outcome, the biomass sequestered annually by trees of given size very slightly increased. There is thus an urgent need to widen investigations on wood density trends across tree species and forest contexts, and to incorporate them in forest carbon accounting approaches.

O6 - Damaging agents in different forest types for adapted risk management

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Species diversity at stand level is one of the strategies proposed in adaptive forest management to minimise the risk impeded by a changing climate. The idea is that species susceptibility to specific biotic and abiotic damaging agents varies, thus reducing the risk of large-scale effects and increasing the potential of natural regeneration by the remaining species. However, responses and hazards vary between sites. To assess both on a large scale we use data recorded within the ICP Forests intensive (Level II) monitoring programme since 2006, with plots distributed across Europe aiming to cover typical forest types.

We analyse biotic and abiotic damage signs in different forest structures: mono-species broadleaved (B) or coniferous forests (C), broadleaved- (B-mix) or coniferous-mixed- (C-mix), and broadleaved-coniferous-mixed (BC-mix) forests, composed of the most relevant tree species. A tree is classed as 'damaged' if a sign or symptom was recorded at least once between 2006 and 2010. From 15,837 evaluated trees 56% showed no sign of damage. The highest share of trees with no recorded damage was found in C-mix, followed by BC-mix, C, and B forests. The highest percentage of damage is found in B-mix forests. 82% of all insect occurrences were recorded in BC-mix. Fungi occurred mostly in C forests (62%). With two thirds of all recorded trees damaged, B-mix seem to be most susceptible; comparing total numbers, however, trees in C forests account for 15% of all damaged trees. Combining records of damage with defoliation estimates of the same trees the highest defoliation in the B-mix type could be due to the high occurrence of damaging agents. C-mix had the second lowest mean defoliation (17%) and the highest share of undamaged trees (79%).

The analysis allows an evaluation of biotic and abiotic damages on a European scale. Mapping of the results will be used to determine potential risk areas for the different signs. The outcome of this study may provide optimized species mixtures for certain areas in order to minimise risks of biotic and abiotic damages.

O7 - Improved water supply of Norway spruce (stands) by progressive thinning intensities

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Climate change will distinctly alter ecosystem conditions, due to rising temperatures, reduced precipitation and weather extremes in the next decades. Severe drought periods as observed in summer 2003 may occur more frequently, causing an increased risk of drought induced damage and secondary pests in forest stands in Germany. Especially Norway spruce (*Picea abies* [L.] Karst.), still the most important economic tree species in Germany, is highly susceptible to drought events. Still, silviculture approaches dealing with future climatic conditions for the management of stands, are scarce, especially for stands being too young to be converted to other stands types.

In the present study, we investigated the water balance response of *P. abies* trees which had been subjected to different thinning intensities. We hypothesized that water supply of selected target trees and the respective stands are improved with declining tree density.

In 2008 an experiment was installed in a 24 years old Norway spruce monoculture near Landshut (Bavaria, Germany). In February 2009 the stand was partly thinned resulting in three intensities: “no thinning” (NT, BA (basal area) 44.2 $m^2\ ha^{-1}$), “medium thinning” (MT; BA of ca. 24.5 $m^2\ ha^{-1}$) and “heavy thinning” (HT; BA of ca. 14.2 $m^2\ ha^{-1}$). Thereby, the medium thinning treatment adopted common German silvicultural forest practise.

The thinning treatments where 40 to 70 % of the initial BA had been removed, led to a decreased stand level transpiration (E_s) of 25.4 % (MT) and 49.7 % (HT) in the first year after thinning on the thinned plots. Differences in stand transpiration E_s were successively reduced from 2009 to 2011 by about 10 % for MT in relation to NT with similar E_s in 2011. On the HT plots, upcoming ground vegetation compensated already in the second year after the thinning the differences in E_s compared to MT by an additional evapotranspiration E_u of about 28.1 % but was still below that of the NT plots until 2011. Nevertheless, during all years studied, the available plant water content was increased with increasing thinning intensity as a combination of decreased E_s and increased throughfall.

Our study showed that the capacity of thinning to improve water availability increased with increasing thinning intensity and persisted at least for 3 years after thinning. If this trend can be confirmed during the upcoming years, thinning seems to be a reasonable option to increase resistance of young Norway spruce stands to drought.

O8 - Local adaptations to frost are stronger in marginal than central populations of the dominant forest tree *Fagus sylvatica* L.

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Local adaptations to environmental conditions are of high ecological importance as they determine distribution ranges and likely affect species responses to climate change. Increased environmental stress in combination with decreased genetic mixing due to isolation may lead to stronger local adaptations of marginal than central populations.

We experimentally observed local adaptations of three marginal and four central populations of *Fagus sylvatica* L., the dominant native forest tree, to frost over winter and in spring (late frost). We determined frost hardiness by the relative electrolyte leakage in a tandem common garden experiment at two locations. The experiment at the colder site included a continuous warming treatment; the experiment at the warmer site included a preceding summer drought manipulation.

In both experiments, we found evidence for local adaptation to frost, with stronger reactions in marginal populations. Winter frost killed many of the potted individuals at the colder site, with higher survival in the warming treatment and in those populations originating from colder environments. However, we found no difference in winter frost tolerance among populations at the warmer site. There, late frost tolerance in April differed between populations, mainly because of phenological differences in bud break. Increased spring frost tolerance of plants which had experienced drought stress in the preceding summer could also be explained by shifts in phenology.

Stronger local adaptations to climate in marginal than central populations imply the potential for adaptation to climate at range edges. In times of climate change, however, it needs to be tested if locally adapted populations at range margins can successfully adapt further to changing conditions. Local adaptations at range margins need to be acknowledged in projections of range shifts, as they expand the realized niche beyond expectations based only on typical, central populations of a given species.

O9 - What Volatiles can tell us about the response of forest ecosystems to climate change

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Volatile organic compounds are released by animals, plants, fungi and microorganisms as an inevitable result of living, as well as by dead organic matter as a result of biogenic or a-biogenic decay. Thus, anabolic and katabolic processes in a forest ecosystem are mirrored in quality and quantity of volatile organic compounds released by this system. We hypothesize that climatic changes like an increased frequency of extreme weather events as storms, late frosts, downpours or droughts will favor some species and suppress others, altering species competition and forest structure. Compromised resource supply and damages will alter volatile pattern released by plants, weakened or dying plants will alter volatile pattern released from changing fungal communities, and these altered volatile pattern will be perceivable by forest insects relating to them an altered habitat quality available. Consequently, the preference and performance of forest insects can change resulting in selective damage to weakened tree species and an accelerated change of species composition in the forest ecosystem. The effect of abiotic stress as posed by extreme whether events on volatile pattern of trees will be presented on different time scales and related to forest stand volatile pattern. The ability of insects to detect components of these volatile pattern is related to the occurrence of the insects in the respective habitats.

O10 - Microclimatic effects on Central European deciduous trees and their interactions with herbivore insects in the face of climate change

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Research studies have revealed a variation of responses from tree species to the predicted climate change. But there are other important factors like plant-animal-interactions and concurrences that should be taken into account. Actual reactions of trees could vary because of herbivore insect pressure that could change due to direct influence of different climatic conditions (e.g. higher temperatures) as well as indirectly by changes of host plants. For a field study, we selected ten different forest sites along a precipitation gradient in Central Germany. For the representation of different climatic conditions, we investigated north and south expositions at each site as well as upper and lower crown of adult beech individuals (*Fagus sylvatica* L.); and juvenile individuals of beech, sycamore maple (*Acer pseudoplatanus* L.) and hornbeam (*Carpinus betulus* L.) in the understorey. We collected insects with different sampling methods (branch-beating and window flight traps) and adopted indirect assessment methods (observation of leaves for missing tissue, mines, galls and discolouring), additionally. The precipitation gradient of the forest sites ranged from 474 to 873 mm per year. Average day temperature varied up to 1°C and relative air humidity about 12% in the understorey between north and south exposition within one forest site. We found a smaller amount of grub on upper crown leaves, where temperature was higher and air humidity as well as specific leaf area lower than in the understorey and the lower crown. We will present our first study results and discuss the interactions between herbivore insect species, precipitation, microclimate and leaf traits in respect to climate change.

O11 - Disturbance accelerate succession from spruce- to beech dominated forest

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It is assumed that climate change will favour European beech (*Fagus sylvatica* L.) to Norway spruce (*Picea abies* [L.] Karst.) at its northern range margins due to climate change and induced disturbance events. An old-growth mixed forest of spruce and beech, situated near the northern beech margin, was studied to reveal effects of disturbances and response processes on natural forest dynamics, focusing on the understory. We carried out analyses on understory dynamics of beech and spruce in relation to overstory release. This was done based on a sequence of stand and tree vitality

inventories after a series of abiotic and biotic disturbances. It became apparent that beech (understory) has a larger adaptive capacity to disturbance impacts and overstory release (68% standing volume loss) than spruce. Understory dynamics can play a key role for forest succession from spruce to beech dominated forests. Disturbances display an acceleration effect on forest succession in the face of climate change. Beech is poised strategically to replace spruce as the dominant tree species at the study area. Due to an increasing productivity and a lower risk of stand failure, beech may raise into the focus of forestry in southern Sweden.

O12 - Conversion of single-species pine forest stands to mixed decidous forests in north-eastern German lowlands - simulation of effects on carbon budget

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Large areas in north-eastern German lowlands are covered by single-species pine stands. More extreme weather conditions with uncertain effects on different tree species can be expected for the future. In order to reduce the probability of a sudden decline of these forest areas due to the consequences of extreme weather conditions, an overall concept was developed that aims to convert these stands into species rich mixed deciduous forests. They form a portfolio that can develop into different directions depending on how the environment will change. This so called “climate adaptive” forest conversion scenario is compared with a “business as usual” forest management scenario that maintains the current distribution of tree species. Both forest management scenarios were developed using initial values from current forest inventory data, indicators for soil fertility and water, and future climate conditions (STARS) of the forest sites on a small spatial scale.

The purpose of the current study is to quantify the effects of the proposed forest conversion on the carbon balance of forests in a model region in north-eastern German lowlands for the simulation period 2011 – 2100 by the use of the process oriented simulation model Biome-BGC (version ZALF).

The simulation results show that the forest conversion scenario leads to increased stem growth and carbon stocks compared to the business as usual scenario. The carbon stock increase is mainly caused by the fractions stem and soil carbon. The net biome production as an indicator for long term carbon balance is lower for the forest conversion scenario than for the business as usual scenario in the first half of the century but higher in the second half.
In conclusion, the conversion of single-species pine forest stands to species-rich mixed deciduous forests in north-eastern German lowlands increases not only the stability of the forests, but also the net carbon dioxide uptake from the atmosphere and hence helps to mitigate global warming.

P1 - Symmetric and asymmetric competition in forests along the aridity gradient throughout the Iberian Peninsula

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The relevance of competition and the ability of an organism to compete for a given resource might change along the abiotic stress gradient. The Spanish National Forest Inventories provide a solid basis to develop a statistical model of the influence of climate, competition and tree size on species growth. In order to formulate precise hypotheses it is important to distinguish between intensity and importance of competition. Competition intensity refers to the growth reduction due to the influence of neighbours. Competition importance refers to the negative effect of neighbours on growth relative to the effect of other factors. Further it is useful to distinguish between competition for water which is directly related to the climatic gradient, and competition for light which is largely independent. The first can be represented by the symmetric component, the latter by the asymmetric component of competition.

Three hypotheses were assessed applying a statistical model for tree growth: 1) The intensity of asymmetric competition increases with aridity, according to the shade-drought tolerance trade-off, 2) the intensity of symmetric competition, e.g. competition for water, increases with aridity, according to the supply and demand theory, and 3) the importance of symmetric and asymmetric competition falls with increasing aridity, according to Grime´s C-S-R framework.

The results were in agreement with former studies and ecological knowledge regarding general species response to climate and competition. However, the three hypotheses were not entirely supported. The within-species shade-drought tolerance trade-off was only found for broadleaved oaks and beech but not for coniferous pines. The effect of supply and demand was indeed found for all species. In contrast to the third hypothesis, importance of symmetric and asymmetric competition increased with aridity for most species. Only for light demanding pines asymmetric competition importance fell. Hence, in Mediterranean forests the importance of symmetric competition increased relative to asymmetric competition along the aridity gradient. This may cause an additional disadvantage for less drought tolerant oaks compared to pines under climate change.

P2 - What is the lethal dose of 'physiological drought' for forest trees? - The L50SWD concept

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Due to climate change, heat waves and drought are expected to increase in frequency and intensity in Europe. Based on the 'physiological drought' concept, we present a 'lethal dose' approach, related to soil water deficit (L_{SWD}) for the major central European forest tree species.

The pre-dawn water potential (ψ_{pd}) is the key parameter for assessments of 'physiological drought'. According to the equilibrium concept of the soil-plant water potential at pre-dawn time, ψ_{pd} relates to the soil water potential at the lowest soil depth in which plant's root system is able to deplete water resources. This rooting depth meets the definitions of the 'effective rooting depth' (ERD). The 'lethal dose' of soil water deficit (L_{SWD}) represents the critical proportion of plant-available water within the effective rooting depth (ERD) that meets both the critical soil water potential at the lower limit of the ERD and the critical ψ_{pd}.

A lethal impact dose for plant collectives is normally defined as a threshold of 50% mortality. By applying this concept, the soil water deficit (ERD), where 50% mortality in forest tree populations occurs, can be used for determining the $L50_{SWD}$. This $L50_{SWD}$ indicator can be easily implemented in combined climate and soil water models in order to assess potential sensitivity of different forest tree species or species provenances to (future) increased drought events.

In summer 2013, we will start with drought experiments on European beech (provenances) and Norway spruce to determine the $L50_{SWD}$ indicator for both tree species that are reputed to be drought-sensitive.

P3 - The effects of climate change and nitrogen supply on health condition of sessile oak in Hungary

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Several studies report that the frequency of extreme weather conditions (especially droughts) has increased. Since the 1970's severe dry periods have triggered mass mortality of stand forming forest tree species (*Quercus petraea, Quercus robur, Picea abies, Pinus sylvestris, Pinus nigra* and *Fagus sylvatica*) in the Carpathian basin. The decline of sessile oak due to dry periods has been continuously observed for more than three decades.

In order to better understand the effects of climatic extremes and nitrogen supply on the health of sessile oak, we have examined 37 populations. The relationship between the aridity of the last decades and the health status of sessile oak stands was analysed along a transect from the semihumid region in SW Hungary to the semiarid region in NE Hungary. The actual density of the stands demonstrates the "cumulative" health status of the last decades. The number of surviving trees was compared to standard density according to yield tables. We found a significant correlation between Ellenberg's drought index, nitrogen concentration and the health decline (mortality) of oak (R^2 = 0,84). The results suggest that the mortality from drought tolerance is considerably influenced by nitrogen supply.

These results may help to understand the area changes of oak forests. Furthermore, finding the reasons of these changes in the past few decades can help to better project possible changes in the future.

P4 - Which management option will provide the highest tree size diversity in European beech forests?

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According to the IPCC SRES A2 CO_2 emission scenario and regional climate change projection, which was used in this study, temperature in some parts of Serbia will rise for about 3.8 degrees Celsius before the end of 21st century. The aim of this research was to find out which of four different management scenarios (0%, 10%, 20% and 30% of selective thinning every 10 years) under three climate periods (1971-2000, 2011-2040, 2051-2080) will provide the largest tree size diversity at nine representative uneven-aged European beech stands in Serbia. Forest stands growth under changing climate conditions and different management options were performed with 4C model, while Gini coefficient was used for calculation of tree size diversity at the end of three 30 year's simulation periods. Obtained results showed that the final tree size diversity fluctuated significantly among different stands, scenarios and climate periods. Every management scenario provides the highest diversity at last at one stand and at one climate period. Several times the high intensity (30%) selective thinning management option provides the highest diversity, while in average no-thinning option provides the best results, medium intensity (20% thinning) scenario was on second place, high intensity (30% thinning) scenario on third place and low intensity (10% thinning) scenario was the last. In average, there were no differences in ranking among different climate periods.

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P5 - Interactions between precipitation, microclimate, leaf traits and herbivore insects on the European beech (Fagus sylvatica L.)

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In Germany a high amount of forests is used as timberland with coniferous species, though the beech (*Fagus sylvatica* L.) would be the main tree species in most of the Central European forests. Many research has been done about reactions of single tree species and forests on climate change, but yet less about how biotic interactions will be influenced. Biotic systems are very complex and also plant-animal-interactions are important to consider. Pressure of herbivore insects on trees could change due to direct influence by higher temperatures as well as indirectly by changes of host plants. We studied *F. sylvatica* at different forest sites along a precipitation gradient in Central Germany. At each site, we investigated adult individuals on north and south expositions for representation of different microclimatic conditions. Furthermore, samples of leaves and insects were taken from upper and lower crowns. We analysed leaves for missing tissue, mines, galls and discolouring as well as branch-beating samples to determine the amount of grub and herbivore insect species. The overall most common species were the beech leave weevil (*Orchestes fagi*), the gall mite (*Aceria nervisequa*), and the European beech leafhopper (*Fagocyba cruenta*). We found a smaller amount of grub on upper crown leaves, where air humidity is lower and temperature higher than in the lower crown. We will discuss how interactions between insect herbivores and environmental changes affect *F. sylvatica* and how these interactions can be taken into account to make predictions about the future of this species under climate change.

P6 - On the dynamics of Ivy (*Hedera helix* L.) in Central European beech forests on limestone - Results from monitoring and experimental studies

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A spread of ivy (*Hedera helix*) and other evergreen, oceanic-distributed plant species into deciduous beech forests has been observed during the last 20 years in Central Europe. As this species is susceptible to long and intensive frost periods, it is believed that climate change causing mild winters is the responsible driver for this spread. Other factors, however, might as well be beneficial for *Hedera helix* including changes in forest management, eutrophication and a reduction in roe deer browsing. With vegetation surveys from different beech forest communities of the Göttinger Wald (Lower Saxony, Germany) starting more than 50 years ago, we addressed these potential drivers and their influence on the development of *H. helix* in the understorey vegetation.

Observed only occasionally 50 years ago, *H. helix* today is a frequent component of sampling plots in the Göttinger Wald. Contrasting mean monthly temperatures as well as minimum temperatures from the 1950s and the last decade shows a general increase in winter temperature and a decrease in days with temperatures below -15 °C, a crucial threshold for the growth of *H. helix*. This confirms an influence of climate change, whereas forest management in these beech forests does not have an impact on the development of this evergreen species. Fertilization experiments (adding nitrogen, phosphorus and a combination of both) and exclosure plots, however, underline a potential positive influence of eutrophication and a reduction in deer browsing – caused by an intensified hunting in the study area – on the abundance of *H. helix* as well.

Thus, a main driver of the observed abundance changes could not be identified. We assume that the spread of *H. helix* in the Göttinger Wald is caused by a complex interaction of changing abiotic (climate change and eutrophication) and biotic (roe deer browsing) condition, that is not fully understood yet.

Session 12 - Individual-based ecology: from basic principles to predictive theory

Chairs: Uta Berger, Volker Grimm

O1 - Individual-based ecology: from basic principles to predictive theory

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The structure and dynamics of ecological systems emerge from what individual organisms do: interact with each other and their environment and adapt their behaviour to their own state and to current environmental conditions. Individual-based ecology (IBE) aims at exploring the mutual relationship between the behaviour of individuals and the structure and dynamics of populations, communities, and ecosystems. Individual-based models (IBM) are a central tool in IBE. Over the last decade, awareness has increased that in order to be truly predictive, IBMs need be more based on basic principles, for example physiology, metabolic theory, or fitness seeking. We present both an overview of such principles and examples of how they can be used in IBMs. We then discuss how predictive theory can emerge from such IBMs, and how the classical separation of theory and application no longer holds for Individual-based Ecology.

O2 - A systems approach for understanding the role of multiple stressors on honeybee decline: the integrated model BEEHAVE

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The long-term decline of managed honeybee colonies in Europe and USA is of increasing concern. Single drivers of this decline are discussed, but the corresponding evidence is still equivocal. Hence, a combination of stressors, e.g. parasites, pathogens, pesticides, and land use changes might cause the observed increased mortality of honeybee colonies. Empirical testing of stressors in a systematic way would be extremely challenging. Hence, mechanistic modelling should supplement field research and help detecting the limits of resilience mechanisms acting within honeybee colonies. BEEHAVE, developed by M. Becher at Rothamsted Research, UK, and co-workers, is the first model designed to explore the role of multiple stressors of honeybees. Its within-hive module describes colony structure and dynamics; the mite module incorporates the dynamics of a Varroa mite population acting as vector for viruses which affect bee mortality; the foraging module represents

foraging dynamics in heterogeneous and dynamic landscapes by including relevant properties of flower patches and the bee's collective foraging behaviour. We used BEEHAVE to explore how varying foraging distances, availabilities of nectar and pollen, and infestations by infected mites affect colony survival. This allowed identifying the `tipping points` of resilience of honeybee colonies in hypothetical landscapes. A key resilience mechanism is the variable age of transition of in-hive bees to foragers, which depends on colony composition, stores of nectar and pollen, and food availability in the landscape. This transition is strongly affected by the total foraging distances of the colony. We thus determine this distance, and the corresponding foraging efficiency, for a range of stylized and real landscapes and thereby test foraging efficiency as an indicator of the resilience of honeybee colonies. We suggest experiments by which this indicator, and the proposed resilience mechanisms, can be tested.

O3 - "Prediction is very difficult, especially about the future" Implications from ecological theory to specify the self-conception of ecological modelling

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Ecological modelling uses the knowledge about specific ecological interactions to uncover resulting implications when integrated in networks and being iterated. This facilitates the possibility to represent statements about implications of empirical knowledge gained on smaller scales and shorter terms with regard to larger scales and longer terms. In particular the potential and conditions for effects like dynamic equilibria, instabilities and phase transitions can be analysed. With this scope, ecological modelling significantly contributes to expand ecological knowledge.

Predictions arise if a statement about the future is made. This implies not only, that sufficient structural and quantitative identity of a real interaction network with a model-setup is claimed. In addition the fulfilling of an implicit completeness claim is made. In addition, a ceteris paribus condition is required to be met. To secure these aspects which are necessary for a prognosis in an ecological context usually remains outside the scope of what is scientifically possible. To prevent false expectations it is therefore suggested to avoid the term prognosis and emphasise that ecological models help to discover implications in existing ecological knowledge.

The presentation supports the point of view that prognoses are unreasonable as a general goal for ecological modelling. It uses theoretical and epistemological considerations about the characteristics of living entities and the way they interact with their environment and how to represent this in formal settings.

O4 - Validation of Individual-based Models: A Hierarchically Structured Approach to Consider Structural and Qualitative Implications

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Validation is vital for model development and subsequent application as it ensures that a model is applicable for the intended purpose and that results can be trusted within the limits of model assumptions. Individual-based models (IBM) can operate on different organisation levels and higher level results often emerge from a self-organisation process of interacting lower level entities. How these entities interact may be inherently variable and may depend amongst other upon local spatial conditions.

Thus, the commonly used validation approach by comparing independent empirical data sets statistically with the generated model results is not sufficient. For individual-based models, a more sophisticated approach is necessary which requires additional investigations, including qualitative as well as structural relations.

In our contribution we describe a hierarchically structured validation approach in which the different hierarchical levels covered in the model are assessed individually/separately and qualitative and structural aspects are also considered. Several validation techniques, such as (i) visual inspection, (ii) statistical comparison, (iii) involvement of experts, (iv) aggregation of data on higher integration levels and (v) experimental validation are applied on each of these levels in accordance with the specific model questions and model organisation. A literature survey illustrated that validation techniques are not widely used in individual-based modelling. With the outlined approach we want to contribute to the theory of model validation and account for the specificity of individual-based models.

O5 - The impact of forest dynamics on vascular epiphytes - An individual-based modeling approach

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Vascular epiphytes make up approximately 10% of the global vascular flora. Their abundance, diversity, and community structure vary widely across spatial scales and climatic factors are often assumed to determine their distribution patterns. However, forest dynamics might also play a major role at local scales. In a forest, new potential substrate (i.e. branches, stems) is constantly being created by tree growth and sprouting, favoring epiphyte establishment, but is also lost through branch fall and tree mortality, contributing to epiphyte mortality. Such effects of forest dynamics on epiphyte population and community dynamics are rarely investigated because of the methodological limitations to accessing forest canopy and the lack of long time-series. Therefore, we aimed to assess the importance of these effects by developing a mechanistic model. We used a growth grammar-related modeling platform (GroIMP) to simulate 3D forest dynamics. We simulated scenarios differing in their forest dynamics by varying the rate at which substrate is created and lost and by integrating different disturbance regimes (i.e. strong winds or severe droughts). These forest scenarios were coupled with an individual-based model of epiphytes which integrated key ecological processes including growth, reproduction and mortality. We found strong effects of forest dynamics on epiphyte dynamics. Epiphyte abundance within a plot was largely controlled by the level of forest stability, and the impact of major disturbances persisted over a long period. Disturbances increased selective pressure on community structure; in particular epiphyte species with slow life cycles or low reproduction rates had a higher risk of becoming locally extinct. This influenced not only the distribution of epiphytes within the tree canopies, but also local richness. Our results indicate that forest dynamics are a non-negligible factor that is able to structure the epiphyte community and must be considered in addition to climate for a full understanding of epiphyte dynamics.

O6 - Migratory animals - from individual migration strategies to links between distant communities

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Myriads of animals from diverse taxonomic groups migrate within their annual or life-cycles. The timing of migration as well as the choice of sites along migration routes has widespread consequences: Individual fitness is highly determined by time and body condition at arrival in the breeding grounds, which in turn, is affected by biotic and abiotic conditions on intermittent stop-over sites en route. Thus, in seasonal environments, the various challenges during migration basically come down to a question of being at the right place at the right time. However, (how) can migrants assess the development of resources from afar? How would migration strategies change as dependent on the predictability of site conditions?

In addition to consequences at the individual (or population) level, migration strategies will also have wider implications: With their movements over hundreds or thousands on kilometers, migrants link vastly distant and highly different communities and ecosystems. What is their role in these communities, how do they contribute to ecosystem functions, in how far does it matter that migrants (predictably) appear and disappear at specific times, often in large aggregations – all these questions have remained largely elusive but given the huge number of species and individuals involved, migrations have an enormous potential of altering community structure, dynamics and ecosystem function.

Using a suite of theoretical approaches, I will show how (the degree of) environmental information and predictability can alter migration strategies and ultimately influence individual fitness but I will also show the various roles of migrants in community dynamics and ecosystem function.

O7 - The early bird catches the worm: predicting density-dependent population dynamics from individual foraging behaviour

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Demographic rates are often measured at the population level. Yet, they are not population-inherent properties but emerge from individual behaviour and interactions between individuals. Here, we present an individual-based model of white storks (*Ciconia ciconia*) that explicitly simulates foraging behaviour in a spatially explicit heterogeneous landscape. Carrying capacity and reproductive success are not induced but are emergent properties resulting from competition for resources. Our model shows that carrying capacity and the exact form of density dependence in reproductive success may differ substantially between landscapes that are comparable in the degree of fragmentation and overall resource availability. These findings emphasise the importance of accounting for complex interactions between individual behaviour and small-scale environmental conditions. We further outline how high-resolution GPS-tracking may add to refining and validating such individual-based models, reconciling theoretical and empirical aspects of individual-based ecology.

O8 - Identity recognition and developmental plasticity in young trees: implications for plant cooperation

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Identity recognition is an important mechanism in promoting the evolution of cooperation. While several studies have reported that plants also have the ability to distinguish neighbouring plants and to adjust development discriminatingly in competitive interactions, it has not been shown explicitly that plants behave so in facilitative interactions (cooperation) though plant facilitations are ubiquitous in nature. Here we show in the red mangrove (*Rhizophora mangle*) as an example that plants react explicitly to their neighbours by changing their architecture. Saplings developed more and broader prop aerial roots towards conspecific neighbours, but did not when neighbours are heterospecific plants. This is because the tangled networks of prop roots with conspecific saplings can facilitate the establishment success of the latter, e.g., to resist physical stress by waves or by trapping enhance nutrient-rich sediment. Our study provides evidence that red mangrove can detect and react to con- and heterospecific neighbours discriminatingly by adjusting developmental plasticity. Furthermore, these findings also imply that plants not only react to neighbours competitively but may also react cooperatively, and the cooperation is more likely to occur in species experiencing environmental stress. The ecological implications of such sophisticated plant behaviours represent an important mechanism for how plants cognitively integrate information about both abiotic and biotic based cues in their environment and adjust their developmental plasticity accordingly. The study provides further evidence that the consideration of basic principles such as adaptation and fitness seeking is crucial for understanding the mutual relationship between the behaviour of individuals, the local environment, and the structure and dynamics of plant communities.

P1 - Phytoplankton diversity and nutrient status

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Whether there exist universal mechanisms determining biodiversity at a given system has been a long standing question of ecological research. In this context, role of nutrient status is of critical importance, obviously due to the alteration global nutrient cycles by the anthropogenic activities at ever-increasing rates. Data from marine, lake and mesocosm systems suggested recurrent inverse relationships between planktonic diversity as a function of size and nutrient status at seasonal scales. Here, we relate the coherent features of these otherwise profoundly different systems to intrinsic biophysical rules determining traits and trade-offs governing the structure and organization of planktonic communities. By integrating these rules in adaptive size-based models, we attempt to reproduce the variability in biodiversity observed in situ. Our model analysis also reveals how

biodiversity shifts in turn may affect ecosystem functioning. Trait-based models – if devised in a mechanistically sound way - may thus provide valuable frameworks to jointly assess loss of biodiversity and alteration of global nutrient cycles.

P2 - Spleen and bursa mass of rock ptarmigan in relation to parasite infections, age, sex and year

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The spleen and bursa of Fabricius are important organs of immune function in birds. They are known to play a major role in fighting parasite infections. In particular spleen, but also bursa size is commonly used as a measure of immune investment. The bursa only occurs in juvenile birds and regresses before sexual maturity. We investigated spleen and bursa mass and parasite burden (parasite richness, load, and presence/absence) of 339 rock ptarmigan *Lagopus muta* collected in northeast Iceland in the first week of October 2007-2010. All birds were infected with at least one parasite species. Our results revealed that immune investment as expressed by increasing spleen and decreasing bursa mass in juvenile birds was associated with parasite richness and/or load (in particular, of Coccidians and certain Acari and Mallophaga) in ptarmigan in Iceland. Both organs showed an inverse relationship. Variation in spleen and bursa mass was associated with the age of the birds. For adult spleen and juvenile bursa mass variation was due to the birds' sex, and for juvenile spleen mass it was due to variation among years. Juvenile birds had overall higher spleen mass than adults. While spleen mass did not differ among juvenile males and females, adult females had higher spleen mass than adult males. Bursa mass of juvenile females was greater than that of males. The decrease in bursa mass with increasing parasitic burden is a novel observation and opposite of what has been found previously. Similarly, the simultaneous increase in spleen mass and decrease in bursa mass due to parasite burden in juvenile birds is to our knowledge a new discovery. There was inter-annual fluctuation in spleen mass in juvenile birds. Spleen mass increased from 2007 to 2009 and decreased in 2010 which is in synchrony with the fluctuating ptarmigan population size in Iceland. Overall, spleen and bursa mass appear to be a suitable indicator of immune investment to parasite burden. The bursa needs however more detailed investigation if we intend to better understand its role in immune function and parasite defense in the ptarmigan. Despite these findings, parasite burden in the ptarmigan may not be the only explanation for increased spleen or decreased bursa size in juvenile birds and other factors (e.g., bacteria, viruses, body condition) may be important.

Session 13 - Macroecology - linking species diversity with traits and phylogenies

Chairs: Christian Hof, Katrin Böhning-Gaese

O1 - Macroecology in an age of global change

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"Learning from the past and understanding the present in order to predict the future" - under this headline we can summarize the current (macro-)ecological research agenda in a changing world. It is widely acknowledged now that to understand the distribution of Life on Earth we have to move beyond simple correlations between species richness and contemporary climatic conditions. Instead we need to increase our knowledge about the history of species, their distributions, and the environment, as well as about species' traits which mediate the responses to environmental conditions. This increased knowledge does not only greatly enhance our ability to explain current diversity patterns; it also serves as the basis for scenarios which outline potential futures of species distributions and diversity.

Here, we illustrate the potential, but also the challenges of macroecological approaches that try to combine (i) spatial information on species distributions and environmental conditions, (ii) population dynamics, (iii) phylogenetic information on the evolutionary history of species and clades, and (iv) trait information related to behaviour (migration) and physiology (thermal tolerances and metabolic rates). Using birds and mammals as study groups, we show how to integrate these diverse aspects in order to move towards a better understanding of present diversity patterns, and thereby to work for better projections of the future of biodiversity.

O2 - Biogeographic patterns of Neotropical forests

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Based on more than 400 tree species inventories taken from the literature, we analyse gradients of floristic similarity of Neotropical forests using multivariate statistics. To minimize problems with misidentifications at the species level, the analyses focus at the family and genus level. The dataset covers information on more than 1,300 genera and almost 200 plant families. Though there are already a few meta-analyses of Amazonian forest inventories, large scale analyses including other biogeographic provinces like the Northern Andes, the South-East Brazilian Forests, or Central America are still scarce. The aim of our analyses is to present a biogeographical classification of the forest inventories in our dataset, to analyse the floristic turnover along major environmental gradients, and to identify characteristic genera and plant families for the different forests on a continental scale. Results include, e.g., different altitudinal gradients for canopy and understory trees in the Northern Andes, or the comparably low diversity of palms in the SE Brazilian forests.

O3 - Macroecology of parasites

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In contrast to free-living species, surprisingly little is known about the patterns and drivers of large scale distributions of parasites. Here, I summarise several recent studies on diversity, abundance and range size patterns of marine and freshwater macroparasites. The motivation for such studies is two-fold: on the one hand, parasites deserve interest in their own right as understanding patterns and processes in parasite distribution and abundance helps to evaluate the generality of macroecological theory. On the other hand, such an understanding helps to determine large-scale patterns of disease risk for hosts, for which parasites are well known ecological and evolutionary drivers. I will illustrate that parasites share some macroecological patterns and processes with free-living species but that there are also some parasite-specific drivers like host diversity and dispersal capacity.

O4 - What are the environmental drivers of arbuscular mycorrhizal and non-mycorrhizal plant species?

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Symbiotic relationships formed by arbuscular mycorrhizal fungi (AMF) and terrestrial plants are of great importance for both, the partners' ecology and shaping plant communities. As AMF are widely distributed across most terrestrial ecosystems and possibly establish a symbiosis with at least 75% of all vascular plant species, surprisingly little is known about the biogeography of AMF and the environmental drivers of mutualistic and non-mutualistic plant species.
We used generalized additive models (GAMs) to analyse the distribution of more than 1300 plant species of the German flora using AM status information (obligatory, facultative and non-

mycorrhizal) collated in the MYCOFLOR database. Climatic and land use related predictors were used to model the distribution on the German country scale. The model explains more than 50% of the variance in the used data. Thus, variables related to temperature, i.e. mean annual temperature and annual temperature range as a measure for the influence of continental climate, and precipitation (annual mean and range as well) have the highest explanatory power. Additionally, the degree of urbanity, different types of forest cover (coniferous, mixed, and deciduous) and types of geology play a significant role in shaping the distribution. As there is spatial autocorrelation in the residuals of the model, we are trying to correct this bias to improve the model's explanatory power as a next step.

As AM plants are mostly showing a low specificity in their fungal symbiotic partners, gathering knowledge around the mycorrhizal status as a plant trait may potentially help to predict the establishment of alien plants. Furthermore, the interactions of alien species with mutualists are important in understanding their impacts on changing the composition of functional traits in recipient, native plant communities.

O5 - Resource availability predicts host specificity of phytophagous insect faunas on trees in Central Europe

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Ecological specialisation is hypothesized to depend on a number of factors such as resource availability, interspecific competition or historical settings. Here, we analysed the phylogenetic affiliations and the specialization of phytophagous insect faunas on 25 tree genera in Germany considering insect and tree phylogenetic relationships, tree distribution, tree taxonomic isolation, tree height and the tempo of postglacial re-colonisation of trees. Specialisation of insect faunas was estimated by means of the PD Root, an index including the phylogenetic position of hosts exploited by an insect within the host phylogeny. As a much simpler index of specialisation we considered also the proportion of species restricted to feed on one host.

Most of the tree genera are colonized by more closely related insect species than expected from random host-plant selection. Specialisation of insect faunas increased with increasing tree distribution, while the importance of tree height, tree taxonomic isolation and the tempo of postglacial re-colonisation depended on the details of analysis and specialisation index used. The phylogenetic relatedness of trees did not influence the results.

Overall, our analyses support the apparency hypothesis which suggests that insects rather specialize on predictable or abundant than on rare hosts. Increasing specialisation seems to be accompanied by the accumulation of phylogenetically closely related insects suggesting that co-evolutionary processes influence the assembly of insect faunas on trees. Our results also underline the importance of processes operating on larger temporal and spatial scales for predicting the composition of insect faunas.

O6 - Beyond area, isolation and age: what determines species diversity on oceanic archipelagos?

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Understanding the factors that influence biodiversity still constitutes one of the greatest challenges in modern ecology. Island biogeography has traditionally focused on area and isolation as key factors driving island diversity. Recent advances in this field have suggested the role of habitat heterogeneity, geological origin and island age as further factors. However, these studies often neglect that oceanic islands normally are found in archipelagos, whose geological dynamics and landscape properties might have played a significant role. In this study, we aim to address the role of intra-archipelago connectivity alongside with typical and extended biogeographical measures on archipelagic α- (mean over single islands), β- (turnover among islands) and γ-diversity of vascular plants. For 23 oceanic archipelagos, we additively partitioned γ-diversity into α and β components, whereas β-diversity in its turn was further partitioned into β-replacement and β-nestedness components. We used a range of abiotic (climatic, landscape and biogeographical) variables as explanatory variables in simple and multiple regression as well as structural equation models. Results revealed that climatic variables act on both α and β components, but most strongly on α-diversity. Biogeographical variables (archipelago age, isolation, total area and maximum elevation) acted on both α and βcomponents, whereas landscape measures (number of islands, mean distance between islands, area range, connectivity and environmental heterogeneity) strongly influenced β-diversity. These results open an avenue for island biogeography research by integrating hitherto neglected connectivity measurements and assessing their role on driving diversity on oceanic archipelagos.

O7 - Regional patterns of endemism and diversity on a mountainous oceanic island

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The factors driving speciation and therefore endemism on regional scales are still largely unknown. Patterns and drivers of endemism are best studied on islands where most endemic species can be assumed to result form in situ speciation. Distinct patterns and their dependence on environment are optimally studied in the presence of steep environmental gradients and complex topography. Accordingly, we collected data of single island endemic plant species (SIE) in almost 2000 sampling sites on La Palma, Canary Islands (max. elevation of 2426 m) and combined them with high-resolution (i.e. 100 x 100 m) climatic, geological, land use, elevation and other environmental data. Ensemble modeling was used to calculate the spatial distribution of each SIE species and then combined to measures of richness distribution. SIE richness varied strongly within the island with the highest numbers found in the steep northern coastal areas, while lowest values were associated with recent volcanic activity on the southern tip of the island. The percentage of SIEs increased with elevation and was negatively correlated with precipitation. This can be interpreted as an increase of diversification rate with elevation. This large dataset contains an unprecedented spatial resolution (almost 3 sampling sites per km^2) and quality and is therefore highly valuable for species distribution modeling approaches. Thus, further questions associated with the effect of climate change on endemic plant species or differences in niche size between species groups can be effectively tested.

O8 - Phylogenetic diversity and composition of island floras

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Islands have long been subject to biogeographical research and are crucial for developing theories in ecology and evolution. So far, most global-scale analyses of island biodiversity have focused on species richness and community composition. Due to their discrete and isolated nature, however, islands are also perfect natural laboratories for investigating phylogenetic diversity and its relationship to environmental characteristics. For example, environmental and dispersal-related filtering in combination with adaptive island radiations is expected to result in phylogenetically less diverse, highly clustered assemblages. Here, we investigate deviations from null expectations in phylogenetic diversity and structure of island floras in relation to available area, isolation from

potential source landmasses, geologic setting, island age, environmental heterogeneity as well as past and present bioclimate for a set of 393 islands and 36,297 species. We compare Angiosperm and Pteridophyte assemblages using dated family-level phylogenies. To reveal patterns at the genus level, we compare palms (Arecaceae) to Pteridophytes using dated genus-level phylogenies. Both groups differ in their dispersal modes and accompanying traits like long-distance dispersal ability and gene flow. We therefore expect contrasting patterns in phylogenetic diversity and structure in relation to island characteristics. Initial results suggest that palms are phylogenetically less diverse on remote islands whereas all angiosperms as well as ferns show no significant or contrasting trends. In general, phylogenetic diversity seems to decrease with increasing island area and island age, possibly reflecting in situ speciation events. We show how island characteristics determine the phylogenetic structure of island floras and point out where phylogenetic diversity most strongly deviates from species richness. Our findings may help to better understand the composition of insular plant assemblages in relation to physical constraints and the abiotic environment.

O9 - Phylogenetic patterns of climatic, habitat and trophic niches in a European avian assemblage

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The origins of ecological diversity in continental species assemblages have intrigued biogeographers for a long time. We apply phylogenetic comparative analyses to identify evolutionary patterns of ecological niches in an assemblage of European birds and we compare phylogenetic patterns in trophic, habitat and climatic niche components. We assembled data on geographic range, habitat use and trophic habits on 405 species of breeding birds in Europe. We then fitted Pagel's lambda and kappa statistics, and conducted disparity through time (DTT) analyses to compare temporal patterns of ecological diversification on all niche axes together. The observed patterns were compared to expectations based on neutral (Brownian) models of character evolution. In this avian assemblage, patterns of phylogenetic signal (lambda) suggest that related species are generally more divergent in their climatic and habitat niches than they are in their trophic niche. Kappa estimates show that ecological divergence did not gradually increase with divergence time, and that this punctualism was stronger in climatic niches than in habitat and trophic niches. Disparity dramatically exceeds levels expected from a neutral (Brownian) model of ecological diversification, thus providing no evidence for phylogenetic niche conservatism in these multivariate niches. Levels of multivariate disparity are highest for the climatic niche, followed by disparity of the habitat and the trophic niches. Thus, phylogenetic patterns in the three niche components differ within this avian assemblage. Variation in evolutionary rates and/or non-random, macroecological sampling likely lead here to differences in the phylogenetic structure of niche components. Testing hypotheses on the origin of these patterns will require extended ecological data on different niche components for all bird species.

O10 - Phylogenetic niche conservatism and the fossil record: a case study using fossorial reptiles.

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Phylogenetic niche conservatism (PNC), i.e. the idea that taxa will retain similar ecological traits over time, has become a popular concept in evolutionary ecology. Most studies, however, are exclusively based on extant ecologies and do not consider paleoecological data. Here we use a clade of fossorial reptiles, rhineurid amphisbaenians, to investigate the evolution of environmental preferences from deep time to the present. Rhineuridae contain only a single extant species, *Rhineura floridana*, which is restricted to the Florida Peninsula, but the clade has a rich fossil record in the Cenozoic of North America. We compared precipitation, temperature and soil type as inferred from species niche modeling to what is known from the fossil record, and considered the evolutionary history of Rhineuridae to track paleoecological shifts. Niche modeling suggests that the modern species' distribution is most likely not limited by rainfall and temperature, but instead is controlled by the unique soil characteristics of Florida. Plasticity in precipitation tolerances is supported by the fossil record, as *R. floridana* occurred in Florida also during drier glacial stages. In Rhineuridae as a whole, we observe a shift from subtropical-humid to semi-arid savannah conditions during the Eocene-Oligocene transition, with variation in preferred paleosols. A range shift is seen in the disappearance of the clade from northwestern North America after the mid-Miocene, and we hypothesize that the extinction was due to a combination of cooling and drying. However, the environmental tolerances of modern *R. floridana* cannot be used to explain this shift, as fossil rhineurids display variation in all relevant climate and soil categories; as such, the modern relict endemism of the clade is surprising given its ancestral ecological plasticity. Our study emphasizes the importance of deep-time information for the understanding of modern ecologies, especially regarding assumptions on PNC.

O11 - Exploring the determinants of phylogenetic diversity and assemblage structure in conifers across temporal, spatial, and taxonomic scales

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Composition, diversity, structure and function of modern plant communities are strongly related to the current environment, but they may also depend on past eco-evolutionary dynamics. For example, climate change can exert a strong influence on lineage diversification and niche evolution, and thus have long-lasting effects on species pools and local assemblages. Integrating such long-term dynamics with short-term ecological processes in a common analytical framework is a major challenge of integrative biodiversity science. Phylogenetically informed diversity measures and palaeo-environmental models are important elements in this framework. Here, we integrate both types of data in order to explore the determinants of forest tree diversity using the conifers as a

model group. Conifers are an old, diverse (ca. 650 spp. in 6 families) and widespread group of woody plants of high ecological and economic importance. They are better studied than most other globally distributed groups of forest trees, allowing integrative studies with high phylogenetic and spatial resolution. We analyse phylogenetic diversity, assemblage structure, and diversification rates for regional conifer assemblages throughout the natural range of the group (269 TDWG3 "botanical countries") to infer the effects of current and past climate. To explore the effects of taxonomic and spatial scale, we deconstruct the overall pattern into families and perform a fine-scale analysis for one particular lineage (the genus *Pinus*, 111 spp.). In particular, we address the hypothesis that long-term palaeo-climatic stability has a major effect on forest tree assemblages, requiring us to interpret and analyse the diversity and function of modern forest ecosystems on much larger timescales than is usually done. Together, those analyses will allow an integrated view of the ecological and evolutionary processes underlying the diversity and structure of conifer assemblages worldwide.

O12 - Linking declines in diversification rates to biogeography and ecological niches: a comparative study in passerine birds

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Recent studies have found opposing temporal and geographical patterns in diversification rates within and across taxa. Many clades seem to have experienced diversification rates that declined over time, a pattern which can be linked to competition for shared resources and increasing filling of niche space as diversity increases. However, geographic regions also differ in the average diversification rates of taxa currently distributed within them, and mountain and island radiations have often been claimed to be unusual in diversification patterns. We assembled dated molecular phylogenies and species distributions of 32 well-sampled groups of passerine birds with consistent methods to test for links between diversification rates and biogeographic properties of clades. Our groups radiated within all areas of the world and cover a range of ages, proportions of mountain species, and proportions of island endemics. We use this dataset to test whether diversification rates depend on the diversity of the clade or just vary over time, and whether biogeographic properties of the group influence diversification rate parameters. We find that the diversity-dependent model of diversification fits best to most groups, but that results can differ widely when using different dating methods for the molecular phylogenies. Nevertheless, our results show consistently significant associations between diversification parameters and biogeography across our groups. We also show that for some radiations, diversification into different ecological niches and ecological key innovations can play a role in shaping diversification rates.

O13 - On the glacial extinction hypothesis: Is the European tree flora functionally less diverse than North America?

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Glacial extinctions and postglacial dispersal limitations are hypothesized to have resulted into a less species rich tree flora in Europe compared to North America. While species can be more or less similar in terms of their functionality this raises the question whether the functional diversity of trees in Europe is reduced compared to North America. In other words, did glacial extinctions operate random or did they affect species of a certain functional identity?

To explore this question, we will use distribution maps of 258 North American and 103 European tree species to calculate the functional diversity of both floras based on 26 functional traits. Based on this, we will (1) derive maps of European and North American forest functional diversity, (2) compare the functional space of climatically similar regions between both continents and (3) identify the traits responsible for differences in these patterns.

In general we find that there is a large amount of shared trait space between both continents. The functional richness of North American trees flora is higher compared with the European tree flora. For similar climatic regions Gymnosperm functional richness is higher in North America than in Europe whereas the opposite is true for Angiosperms. Our analyses show a large amount of functional similarity among North American trees. The most important traits spanning up the trait space of both continents are related to reproduction and leaves, as well as life form and tree height. Differences between the trait spaces of both continents can be mainly attributed to leaf traits for Angiosperms and root-habit, vegetative spread rate as well as growth rate for Gymnosperms.

These results suggest that the traits space in Europe was non-randomly affected by glacial extinctions.

O14 - Morphological mechanisms and distribution range size in hummingbirds

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Distribution range size is an important aspect for species conservation and the understanding of evolutionary processes. It has been documented in many taxonomic groups and at different spatial scales that the diversity of range restricted species, i.e. endemic species, is correlated to a different range of environmental factors than the diversity of widespread species.

We here show that body morphology in hummingbirds is related to range size and show that the exposed culmen length, i.e. bill size, of hummingbirds is positively correlated with distribution range size. This pattern is independent of body size or elevation. We found no phylogenetic signal in the data set, i.e. subfamilies with small bills do not always have small ranges and those with long bills do not have large distributions.

Bill length is related to the feeding ecology of hummingbirds and can be seen as a mechanism to optimize the utilisation of nectar resources and at the same time to reduce interspecific competition with other hummingbird species. This is the first study showing the influence of a morphological mechanism related to feeding ecology on large-scale species distribution-range sizes in vertebrates. We hope to stimulate the exploration of possible mechanisms in species distribution patterns in other taxa as well to understand evolutionary processes.

O15- Landscape level identification of aquatic pesticide exposure and effect - Pattern, process and prediction

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Landscape level contamination with pesticides in streams occurs from point sources - treatment plants - and non-point sources - diffuse agricultural inputs. Uncontaminated stretches at local and continental scale are present. The spatial heterogeneity is coupled with strong temporal fluctuation of contamination ranging from hours to years. This complex pattern of multi-scale spatio-temporal contamination profile strongly influences trait composition of aquatic communities. The description of ecological effects show that alteration of trait composition in the field occurs at extremely low concentrations of toxicants - orders of magnitudes below those predicted to be safe by the regulatory assessment. Also recovery from toxicant exposure takes surprisingly long in the field. These mismatches between toxicant effects observed in the field and the laboratory based predictions sparked a controversial discussion on effect thresholds among ecotoxicologists. The integration of ecological and ecotoxicological mechanisms allows to explain the observed effects in space and time. Applying this mechanistic understanding enables a better protection of biodiversity and risk assessment of pesticides. Additionally, future predictions of exposure and effect related to climate change are presented and related to possible mitigation measures.

O16 - Mycorrhizas in the Central European flora - relationships with plant life history traits and ecology

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The effects of mycorrhizal associations are intensively studied at the plant individual, community and population level. In contrast, studies at the larger scale are rare, despite the proven strong ecological effects of mycorrhizas on plants at all levels. We collected mycorrhizal status information for ca. 1700 plant species form the Central European Flora in the MycoFlor database. This database will allow to test for general ecological links between the ability to form mycorrhizal associations and the ecology and distribution of plants. In a study on the relationships between mycorrhizal status and a selection of plant traits, we observed strong and pervasive non-random associations of plant life history traits and strategy types with mycorrhizal status. Obligatorily mycorrhizal (OM) species tended to be positively associated with higher temperature, drier habitats and higher pH; and negatively with moist, acidic and fertile soils. Competitive species were more frequently OM and stress tolerators non-mycorrhizal (NM), while ruderal species did not show any preference. Facultatively mycorrhizal (FM) species showed the widest geographic and ecological amplitude. We also found significant interactions between mycorrhizal status, invasion status and invasion success. Interestingly all our analyses point to the fact that there is a clear distinction between FM and OM+NM species in terms of their ecology, indicating that not only the ability to form mycorrhiza is important for a plant but also the option to abandon the mycorrhizal partner.

O17 - Closing the circle: how to return species distribution models into the scientific domain

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Science is the struggle for knowledge ("Erkenntnis"). Since over a century, the Scientific Method has established a "hypothetico-deductive" model, which we all know as the circle from theory to hypothesis to test to confirmation or revision of the theory. Many scientific and research activities are concerned with only a part of this circle, e.g. Formulating theory or experimentally testing

hypotheses others have proposed. As long as research is part of that circle, scientific knowledge can be acquired. Some research activities, occasionally even referred to as “science”, are not part of the circle. They can, fundamentally, not lead to more knowledge. Here I argue that species distribution modelling, i.e. the analysis of spatial distributions of species through correlation with environmental predictors, runs a high risk of become such an unscientific science. While some studies are fully in line with the Scientific Method (in particular much of the macroecological research), most publications are devoid of theory, hypotheses, tests and falsifiable statements. These research activities may have good intentions but are likely to have no long-term legacy (at best) or even cause disrepute (at worst). In this talk I offer an opinionated review of the elements needed to close the circle of the Scientific Method, by putting species distribution modelling in its place.

P1 - Different roles of local disturbance, glacial and present-day climate in determining species, phylogenetic and functional diversity in Chinese forests

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Patterns and mechanisms behind biodiversity in forest have always been a central topic in ecology. To date, many hypotheses have been put forward aiming to elucidate the origin and maintenance of biodiversity. However, to our knowledge, few studies have testified these hypotheses synthetically for species, phylogenetic and functional diversity, all important components of biodiversity. Here based on the community data from Chinese forests and climatic data from WorldClim database, we present a comprehensive discussion about the relative role of local disturbance (ratio of light demanding species), paleo- and present climate in shaping the three diversity components, trying to compare the underlying mechanisms. Interestingly the results show that local disturbance was the best predictor of the functional diversity as represented by maximum canopy height (MH), and thus might reflect the important role of competition for light in determining forest’s MH structure. Species richness was best explained by present-day temperature, while the anomaly between Last Glacial Maximum and present temperature better explained phylogenetic diversity if species abundance was taken into account. Otherwise present-day temperature was also the best predictor of the phylogenetic diversity. Overall, distinct processes seem to shape these three key aspects of biodiversity in Chinese forests.

P2 - Root traits: detecting meaningful belowground characters and linking them to ecologically relevant questions

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Identifying, evaluating and measuring plant traits is becoming more and more important in plant ecology. Traits-based approaches have a long history in community and ecosystem ecology, as well as in evolutionary biology, but databases are still heavily biased against belowground plant traits. Some root traits, such as specific root length or average root diameter have already been identified as correlates of root functioning, plant physiology, whole plant traits or ecological aspects such as plant strategy type. But there is still an insufficient connection between root traits in the context of mycorrhizal associations, above- and below-ground interactions or plant soil feedbacks. We measured root traits of about 150 grassland species from the German Biodiversity Exploratories in pot experiments with field soil. For a subset of 35 species plant soil feedbacks were measured in a feedback experiment with sterile vs. non sterile conditions. We included phylogenetic information of these species in our analyses using maximum likelihood trees to calculate phylogenetically independent contrasts. Preliminary analyses indicate correlations of several root traits with plant soil feedback data as well as significant phylogenetic signals within the dataset, e.g. phylogenetically conserved root traits.

P3 - Roncus Radgost N.Sp., R.Jarevid N.Sp. and r.Crnobog N.Sp.: Three new Cave-dwellers from eastern Serbia (neobisiidae, pseudocorpiones)

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In this study, careful examination of some cave pseudoscorpions from eastern Serbia resulted in the establishing of three more species of false scorpions, which belong to endemic and relict fauna that inhabits the area studied. Three new endemic species of the genus *Roncus* L. Koch (Neobisiidae, Pseudoscorpiones) from eastern Serbia have been described and fully illustrated. Their main characters and important diagnostic features have been analyzed and compared to those of their closest congeners from the area studied. Analysis of the once existing fauna helps in interpreting the origin and history of some Balkan troglobites.

Session 14 - Global climate change effects on carbon, water and nutrient dynamics in the rhizosphere

Chairs: Ina Christin Meier, Marie Spohn, Andrea Carminati

O1 - Protozoa enhance N and P foraging efficiency of mycorrhizal plants

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About 80% of all land plants live in symbiosis with arbuscular mycorrhiza (AM) fungi that provide the host plant with mineral nutrients in exchange for carbon (C). Plants and AM fungi interact in complex belowground networks including bacterivorous protozoa. Protozoa release mineral nutrients from consumed bacterial biomass which may be translocated by AM mycelium to plant roots. Thus, the interaction of AM fungi with protozoa may enhance the foraging capacity of plants for growth limiting nitrogen (N) and phosphorus (P), thereby stabilizing mycorrhizal symbiosis.

We hypothesized that AM fungi and protozoa interactively facilitate plant N and P nutrition, thereby increasing net C fixation and fostering mycorrhizal symbiosis. To test these hypotheses we set up soil microcosms with plants (*Plantago lanceolata* L.) consisting of one compartment with roots and a second with an OM patch with restricted access to AM fungal hyphae.

Mycorrhiza alone did not enhance plant N and P uptake. Protozoa in the OM patch mobilized N from bacterial biomass, and the mobilized N was translocated by AM fungi to the host plant. Presence of protozoa in both the OM and root compartment increased plant net C assimilation and root growth by factors of 2.1 and 2.5. In parallel, total root colonization by AM fungi increased by a factor of 3.1 and this increased the amount of plant N and P by factors of 2.2 and 2.5.

The results indicate that protozoa facilitated plant N and P nutrition *via* the fungal symbiont by triggering plant C assimilation and root growth. Hence, plants need to interact with both AM fungi and protozoa to fully exploit N and P resources in soil.

O2 - Arbuscular mycorrhizal abundance and community structure observed in a tropical montane forest in response to nutrient additions

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Increased nutrient depositions of nitrogen (N) and phosphorus (P) are expected in the future by anthropogenic activities. In order to identify consequences on the pristine tropical mountain forest of Southern Ecuador, a multi-disciplinary nutrient manipulation experiment was established. As part of this framework we are testing effects on a group directly involved in N and P uptake – the arbuscular mycorrhizal fungi (AMF). With its global distribution and association with about 90% of land plants, AMF are also the dominant mycorrhizal form in tropical forests. Likewise, they show a high abundance and clear dominance in the study area.

Here, we tested the effects of N and P additions on intraradical AMF abundance at the community-scale as well as the plant species-scale in plots including control, N, P and NP treatments. For the first, soil samples were taken and roots extracted quantitatively. For the latter, seedlings of three plant species were sampled separately. In both cases roots were stained with Trypan Blue and the percentage of AMF root colonization was determined. Furthermore, AMF community structure (only at the community-scale) was analyzed by pyrosequencing.

We detected a major effect on AMF abundance following N addition. At the community-scale, AMF root colonization decreased significantly, as well as in the case of *Miconia punctata*. In contrast, the most abundant tree species, *Graffenrieda emarginata*, showed an increase in AMF root colonization. The pyrosequencing approach resulted in 78 non-singleton operational taxonomic units (OTUs, 95 – 97% similarity) within the Glomeromycota. Unlike the abundance patterns, AMF diversity decreased in the P and NP treatments.

In summary, these results suggest a strong effect of moderate nutrient additions on AMF in this fragile ecosystem. Impacts on the AMF community and abundance along with species-specific effects might strongly interact with changes in the plant community.

O3 - Root exudate impacts on the temperature sensitivity of litter decomposition

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Warming is predicted to directly increase the activity of soil microorganisms because soil microorganisms and the processes they mediate are temperature sensitive, but the temperature response of litter decomposition is not well established. This may in part be related to other biological and physico-chemical factors in soil that co-regulate microbial activity and litter decomposition rates, such as root exudation. With this study, we assessed (1) how soil temperature affects litter decomposition rates, and (2) how root exudation mediates the impact of soil temperature on litter decomposition rates. To this end we incubated soils with ^{13}C labeled wheat litter under controlled environment conditions at four temperatures (22°C, 25°C, 30°C, and 35°C) for a period of 90-days. To evaluate root exudate impacts on the temperature response of litter decomposition, we added a synthetic exudate cocktail at three different rates of C release (0, 0.7 and 7.2 mg C g^{-1} dry soil) to soils amended with the ^{13}C labeled litter, as well as to soils that received no litter. We found that increased temperature enhanced the rate of litter decomposition, but that the relative increase in litter decomposition in response to elevated temperature was mediated by the quantity of exudate-derived C inputs.

O4 - Decomposition patterns of undisturbed fine roots of temperate tree species

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Through their death and decomposition, plant roots can contributeconsiderably to biogeochemical cycles. Initial decomposition rates of intact root tissue to soil organic matter are affected by root structure and chemistry as well as complex interactions with the soil matrix. This study assessed root decomposition where disturbance of the soil matrix was minimized. We trenched minirhizotron tubes installed 5 years previously in monoculture plots of 10 temperature tree species at a common garden in southwest Poland to identify soil and plant variables that might influence root decomposition. Persistence of more than 900 served fine roots (< 1 mm) was tracked for almost 3 years. Artifacts common to root decomposition studies such as limited access of soil fauna, disturbance of the rhizosphere and large concentrations of root organic matter were thus avoided. By six weeks after the trenching, cross sections of severed roots stained with fluorescein diacetate showed no sign of root vitality in any tree species. Severed roots disappeared faster if new root growth had occurred nearby. Persistence of severed roots increased with soil depth, while increasing soil microbial biomass carbon, labile soil carbon content and earthworms decreased severed-root persistence, as did soil porosity and percent clay content. Severed older roots had higher root persistence than severed younger roots of the two maple tree species. Persistence of dead roots was relatively long in this sandy, infertile soil, ranging from 320 to greater than 974 days, depending on species. In conclusion, the minirhizotrons combined with trenching allowed for tracking the persistence of individual dead roots in an intact root-soil matrix. We found that several factors strongly influenced persistence, including soil depth, number of neighboring roots, and the abundance and activity of earthworms.

O5 - Mutualistic and decomposing fungi differ in reproductive syndromes

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Species have evolved complex traits that form reproductive syndromes according to their life style and environment. We expected the reproductive syndromes of mutualistic ectomycorrhizal fungi to differ from those of saprotrophic fungi since their strategies of resource acquisition considerably differ. The mutualists receive resources from the host, which might provide degrees of freedom in the development of reproductive traits such as fruiting body size. We used data from fungi collected in three consecutive years (> 200,000 fruiting bodies) as well as from the literature. We found clear evidence that evolving to a mutualist leads to larger spores and larger fruiting bodies. We found a trade-off between fruiting body size and the number of fruiting bodies, but this trade-off was similar in mutualistic and saprotrophic fungi. Furthermore, the reproductive syndrome was correlated to the occurrence of ectomycorrhizal and saprotrophic fungi along environmental gradients, but often in contrasting ways. Most interestingly, the average investment into reproduction increased with the soil fertility for saprotrophic fungi and decreased for ectomycorrhizal fungi. Overall, we found clear differences in the assemblages of ectomycorrhizal and saprotrophic fungi along environmental gradients, and these differences can be predicted from their strategies of resource acquisition.

O6 - Extremely low fine root biomass in Larix sibirica forests at the southern drought limit of the boreal forest

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Mongolia's *Larix sibirica* forests at the southern fringe of the Eurosiberian boreal forest belt are exposed not only to very low winter temperatures, but also to frequent summer droughts. It is not completely known how Siberian larch adapts to these stressors. We examined whether (i) these forests differ in their fine-root bio- and necromass from more humid boreal forests further in the North, and (ii) inter-annual fluctuations in fine-root biomass are related to tree vitality. In two exceptionally dry summers, we found only 4-5 g DM m^{-2} of fine-root biomass (FRB; 0-20 cm), which

is far less than typical FRB figures from boreal forests (c. 200-400 g m^{-2}) and the lowest forest FRB reported worldwide; in a moist summer, FRB was 20 fold higher. In contrast to FRB, both necromass (FRN) and non-tree root mass (NTRM) were high in all three years. From the large FRB increase in the moist summer and the generally high root necromass, we conclude that drought-induced fine-root dieback was the likely cause of the very small amount of live root mass in the dry summers. Larch fine roots seem to be more drought-sensitive than shoots, since marked needle loss did not occur.

P1 - A novel automatic minirhizotron system for the investigation of root dynamics under laboratory and field conditions

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The root system - the hidden half of the plant - plays an important part in the carbon allocation and for the uptake of nutrients and water. However, research on plant root systems under field conditions is difficult, because the soil limits the direct observation. There is increasing need to understand the root performance and carbon allocation, and growth under different environmental conditions. The minirhizotron method, in contrast to destructive methods, permits the measurement of the fine root production, mortality and turn-over. However, the technique needs an improved system for image acquisition to optimise the data analysis. We developed a new computer-controlled minirhizotron system with automatic image acquisition. The system is based on a CCD camera (colour or black and white finger camera) mounted to a robotic system and is connected to a portable computer through a USB-video-controller. Positioning of the CCD-camera is computer-controlled by two stepper motors and allows a manually or fully automatic scanning mode. For the root observation glass tubes with a diameter of 30 mm and a length of 70 cm are used. The system can provide quantitative data on fine-root growth and life time, as well qualitative information on root colour, branching and the development of mycorrhiza.

P2 - Influence of root NSC on root exudation and neighbor discrimination between two Central European grass species

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Root exudates are hypothesized to play a central role in belowground nutrient turnover and carbon dynamics, which have influences on plant communications of intraspecific and interspecific competitions. Root non-structural carbohydrates (NSC) concentrations and current carbon fixed by photosynthesis are thought to play crucial role during the processes, however, the reaction mechanisms are largely unknown. We used a novel experiment technique to detect the plant communication mechanism of two common Europe grass species, *Hordelymus europaeeus* and *Bromus ramaus*. By detecting root exudates, root NSC concentrations and other plant indexes of isolated, intraspecific and interspecific treatments under different air moisture conditions. We found that both of the species have intense intraspecific competitions, and *Bromus ramaus* would have advantages over *Hordelymus europaeeus* in interspecific competitions. The influences are displayed mostly as plant biomass and root activity indexes, and achieved through root exudates. The rhizophere effects would direct interactions with current carbohydrates and root NSC concentrations, and the competitions would be intense in high air moisture conditions.

Session 15 - Understanding coexistence in grasslands - Advances and challenges of functional biodiversity research

Chairs: Kolja Bergholz, Rüdiger Knösche, Lina Weiß

O1 - From pots to plots - Predicting field monoculture productivity using traits from pot grown plants

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Trait based approaches appear to be promising to understand the mechanisms leading to community assembly and ecosystem properties. Unfortunately, they often lack root traits, because they cannot be measured on individual or species level using field grown plants.

To resolve this we grew 59 grassland species from a long term biodiversity experiment (Jena Experiment) in pots and measured a large set of traits, including root traits, from four syndromes (roots, leaves, plant stature and reproduction). We use these data to answer the following questions: (1) Do root traits correlate with aboveground traits? (2) Do traits affect monoculture productivity directly or indirectly via individual plant biomass? (3) How much can root traits contribute to trait based models?

We found that root traits correlate with traits of all syndromes but these correlations are generally weak. In all syndromes we found traits that affect monoculture productivity. Specific root area, specific root length and specific leaf area have exclusively direct effects. These traits have no influence on individual plant biomass but are probably important for intraspecific interactions. Stem dry matter content, leaf carbon, nitrogen uptake rate and leaf mass ratio correlate with individual plant biomass, but not with monoculture productivity. Thus, for any reason their impact decreases in community context. Plant height, leaf area ratio and vertical root length distribution are important for both, individual performance and species monoculture performance. For the best multiple regression models traits from all syndromes where selected. However, their predictive power declines with the age of monocultures. Overall, results show, that traits measured on pot grown plants can be a good alternative to field measured traits, especially as root traits can be included as well.

O2 - Leaf trait based characterization of the adaptation to light and moisture in acidic sandy grassland

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There is a well-known relationship between the net-photosynthesis capacity on an area basis and the two leaf traits leaf mass per area (LMA) and leaf nitrogen per area (N_{area}). Therefore we hypothesized an increasing light requirement of the species with increasing LMA and N_{area}. We analyzed leaf trait values of 51 species from acidic sandy grassland with the aim to classify adaption strategies to light and moisture within these communities. The general adaptation of the species was described in the geobotanical niche within the grassland communities *Corynephoretum*, *Diantho-Armerietum*, and *Arrhenatheretum* (geobotanical distribution index, GBDI). Within this niche we compared the LMA x N_{area} index with the GBDI and Ellenberg's light/moisture value for the ability to differentiate various strategies of the species within the grassland light and moisture gradient.

The GBDI was well reflected by Ellenberg's moisture value but it was not significantly related to the light value. The LMA x N_{area} index explained the variability of the GBDI in a similar way as the Ellenberg moisture value. But additionally the LMA x N_{area} index revealed different strategies of annuals and perennial graminoids. At a given GBDI, vernal annuals are characterized by a lower LMA x N_{area} index indicating an adaptation to lower radiation and to higher moisture within the community. That corresponds with their rosette growth form and the lower solar radiation in spring compared to summer time, when most of the perennials have their main performance. Conclusion: Leaf traits provide an opportunity to differentiate the species' adaptation to light and moisture better than the Ellenberg values. However, a clear separation of the adaptation to light from that to moisture with our data was not possible yet.

O3 - Complementary water use along a species richness gradient?

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Niche complementarity in resource use has been proposed as a mechanism to explain the positive effects of increasing plant species richness on ecosystem processes, in particular on productivity. Since hardly any information is available for niche complementarity in water use, we tested for spatially and temporally complementary water uptake along a biodiversity gradient by using stable water isotopes. We hypothesized that water uptake from deeper soil depths increases in diverse compared to low plant species mixtures.

Three times during the 2011 growing season, we labeled soil water in 8 cm (with ^{18}O) and 28 cm depth (with D) of 40 grassland plots along a diversity gradient (2, 4, 8 and 16 species mixtures).

Our results revealed no differences in root water uptake among plots with different species richness, different number of functional groups or with time. Thus, our results do not support the hypothesis that diverse communities use water more effectively than less diverse communities.

O4 - Contrasting foraging strategies of co-existing grassland species: The relevance of mycotrophy

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In oligotrophic ecosystems, such as dry-acidic 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 obviously well-adapted species only develop coarse and narrow root systems, showing their reliance on alternative foraging strategies, e.g. symbiosis with arbuscular mycorrhizal fungi (AMF). Although it is widely accepted that AMF mycelia may substitute for root surface area, there is only little information on the proportion of AMF-mediated nutrition in species with reduced root systems, and, particularly, to what extent high C-allocation into AMF may compensate for the lack of fine roots. To tackle these questions, we quantified the temporal development of belowground C-investment into AMF hyphae and roots together with the potential advantages of either strategy as reflected in growth parameters and soil nutrient depletion in five dry-acidic grassland species belonging to two distinct functional groups: forbs (*Plantago lanceolata*, *Hieracium pilosella* and *Hypochoeris radicata*) and grasses (*Festuca psammophila*, *Corynephorus canescens*), with the forb species generally exhibiting coarser root systems than the grasses. We found that all measured parameters in the forbs were strongly related to mycorrhization, whereas the grasses exhibited no growth increase in response to mycorrhizal colonization. This coincided with a predominant C-investment into AMF and fine roots in forbs and grasses, respectively, clearly reflecting the contrasting strategies.

However, C-allocation into AMF was found to be of similar value for optimizing nutrition as C-allocation into fine roots, as neither growth nor nutrient depletion were higher in forbs than in grasses. Our results clearly showed species-specific strategies in the C-allocation trade-off between AMF and roots, both strategies proving equally effective for life and survival in oligotrophic grassland ecosystems.

O5 - The control of potentially dominant plant species by negative soil feedbacks relates to grassland diversity in Central Europe

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The interactions between plants and soil microorganisms seem to play an important role for the fitness of plant individuals. Thus, plant-soil feedbacks may have a major impact on plant-community composition and on biodiversity. However, little is known about how plant-soil feedbacks influence the local dominance of plant species. Therefore, we hypothesized that plants with large individual biomass that are not locally dominant are most strongly limited by negative soil feedback. In this context, we also investigated the impact of land-use intensification on these plant-soil feedbacks.

In greenhouse experiments, we tested the soil feedback of 35 grassland species differing in local abundance and individual biomass on soils of varying land-use intensity.

Plant species with large biomass and low local abundance mostly experienced more negative soil feedbacks. This effect was especially pronounced in grasses. In addition, land-use intensity had contrasting effects on plant-soil feedback resulting in more negative soil feedbacks for grasses in extensively used grasslands.

Therefore, we conclude that soil feedbacks may control potentially dominant grasses and hence enable diversity in extensively managed grasslands.

O6 - Interactions between calcareous grassland vascular plants and cryptogams - results from greenhouse experiments

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In calcareous grasslands, vascular plant and moss species compete for resources, with interactions ranging from facilitation to inhibition. Whereas many studies show the effects of a dense moss layer on the germination of vascular plants, interactions between mosses and adult vascular plants are rarely studied.

In 2011 and 2012, we conducted two greenhouse experiments with characteristic calcareous grassland species, the vascular plants *Bromus erectus* and *Medicago lupulina* and the pleurocarpous mosses *Hypnum lacunosum* and *Rhytidium rugosum*. The vascular plant species were obtained from a commercial seed supplier whereas the mosses were collected from calcareous grasslands restoration sites. As we wanted to distinguish between physical (competition for light and water) and chemical (allelopathic) effects of the mosses, we combined the vascular plants in containers with either living or dead moss. Other containers containing only the vascular plant species were either watered with diluted moss extract or water (control group). After 6 month, dry weight of all species, plant height and leaf length of the vascular plants, and cover of the moss species were measured.

In a multifactorial ANOVA, we found a significant positive effect of moss cover (living and dead moss) and a significant negative, although weaker, effect of allelopathic compounds (living moss and moss extract) on vascular plant growth. Analysis of the soil water content indicated reduced evaporation in moss-covered containers. We therefore conducted another greenhouse experiment with different watering levels, using the same species. The lowest watering level showed the highest beneficial effect of moss cover on vascular plant growth. We conclude that a dense moss cover reduces evaporation and thereby benefits vascular plant growth in drought-tolerant plant communities. The opposing allelopathic effect shows the complex interactions present even in an experimental setup including only two species.

O7 - Land-use intensity in grasslands shapes the taxonomical and functional structure of arthropod communities

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One universal law in ecology seems to be that communities consist of few dominant and many rare species. What drivers' shape these species-abundance-distributions (SADs) has been a key ecological question and is still the focus of intensive research. Nevertheless, the majority of studies which compared SADs along environmental or human-induced gradients have been conducted in marine ecosystems. In this study, we evaluate the change in SADs of insects and spiders in grasslands along a gradient of land-use intensity in three regions in Germany. Our analysis was based on the niche-preemption theory which treats all species identical except for one specific factor (often the random factor of order of arrival). We included an actual trait into this theory, which describes the ability of a species to (re)colonize its habitat. We expect communities in habitats with higher combined land-use intensity (grazing, mowing and fertilization) to have steeper SADs and to be more strongly dominated by species with high dispersal ability. Indeed, land-use intensity positively affected the steepness of the SAD based on the whole arthropod community and this was driven by a loss of rare species. Furthermore, the proportion of species with low dispersal ability decreased with increasing steepness of the SAD for cicadas. Among the single management components, grazing intensity had the strongest effect on the SADs shape. We conclude that increased land-use intensity in grasslands does not only lead to reduced arthropod diversity but moreover to an increased dominance of already abundant arthropod species. This might additionally translate into a reduction of functional diversity and increase the probability of ecosystem service losses.

O8 - Effects of land-use intensity on phylodiversity of plants and herbivorous insects

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Land-use change and intensification is a major driver of biodiversity loss. If land-use selects for species with traits enabling them to cope with increasing land-use intensities and those traits are phylogenetically conserved, then phylogenetic diversity is likely to decrease along land-use intensity gradients. Such a scenario might differ between different trophic groups due to contrasting resource utilization as well as between rare and common species, since common species are less sensitive to land-use intensification or might even benefit from it. Here we analyzed phylodiversity of plants and true bugs in 148 grassland plots along land-use intensity gradients in three regions in Germany. Overall, we found no consistent decrease of plant phylodiversity with increasing land-use intensity. Magnitude and direction of land-use effects on plant phylodiversity differed between regions, indicating regional differences in land-use effects. Common and rare species assemblages did not show strong differences in their response to increasing land-use intensity in two of the examined regions. In the third region, however, phylodiversity of common species increased and phylodiversity of rare species decreased with increasing land-use intensity. This might be caused by regional idiosyncrasies shaping regional and local species composition for instance differing land-use histories, soil types or pH values. Preliminary results of true bug assemblages indicate a low sensitivity of phylogenetic diversity to land-use intensification but rather strong relationships with plant diversity. This might indicate non-directs effect of land-use intensification on herbivore insect phylogenetic diversity. However, at least mowing seems to decrease phylodiversity of true bug assemblages directly, but again regional differences are apparent.

P1 - The effect of matrix species *Festuca rubra* from regional and cultivar sources on selected grassland forbs

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Given the concerns about the introduction of unsuitable genotypes, regional seed is recommended for use in grassland restoration. However, cultivar seed is often used in seed mixtures. There may be consequences for grassland biodiversity when seed from cultivar and regional sources are mixed. The *cultivar vigour hypothesis* proposes that plants bred for high competitive ability are likely to have an advantage over regional and wild material (Wilsey 2010). The working hypothesis of our study is that cultivar seed is bred more intensively than regional seed and, due to its higher competitive ability, can suppress the fitness components of the forb species (phytometer) more than matrix species of regional origin. In our study, we used matrix species (*Festuca rubra*) from either a cultivar or regional source and measured its effect on a phytometer species (*Buphthalmum salicifolium*, *Dianthus carthusianorum* and *Linum perenne*). Seedling emergence counts, measurements of plant height, plant diameter, longest leaf length and width, number of leaves and flowers and above-ground biomass production of the phytometer individuals were phenotyped

(Mar.–Nov. 2012). Total above-ground biomass production was recorded for the matrix species. Significant differences were observed for phytometer individuals grown with cultivar and regional *F. rubra* for each phytometer species. Interestingly, the phytometer species showed increased above-ground biomass, height, diameter, leaf length and width when grown with cultivar *F. rubra* rather than with regional *F. rubra.* In addition, regional *F. rubra* produced significantly more biomass than cultivar *F. rubra*. These findings are likely to have wider implications in relation to the seed material used for grassland restoration.

Wilsey, B. J., (2010), Dominant and subordinate species responses to dominant grass species and seed sources during restoration. Restoration Ecology 18: 628-637

P2 - Effects of different land use intensities on biodiversity and ecosystem services in grasslands

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Previous studies already have pointed out positive effects of biodiversity on ecosystem functions and ecosystem services. Quite often instruments of biodiversity conservation are faced with interests of human land use. In Germany 52,3% of the total land area are used for agricultural purposes (effective 2011). Especially in that context the importance and the necessity of ecosystem services become painfully obvious, because of their affective role in the production of food and other resources (i.e. for energy generation). An intensification of agricultural land use to increase yields is usually in line with a decline of biodiversity and thus a potentially loss of associated ecosystem services.

These causal relationships and trade-offs between different ecosystem services will be exemplarily investigated in grasslands of different management types along a land use gradient. Meadows and pastures within seven independent study sites in central Germany were chosen to compare the impact of land use intensity and landscape structure on biodiversity as well as functional diversity and the provision of ecosystem services. The analyses will base on assessments of plant functional composition, biomass production, litter decomposition, soil quality and efficiency of pollination.

Furthermore historical vegetation data and information about changes in landscape composition and configuration will be used to identify relationships between land use intensity and biodiversity as well as functional diversity.

P3 - Role of Root Parasitic Fungi in structuring plant communities: experimental microcosm study

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Recent theory acknowledges that the interaction of plants with their enemies is important for plant coexistence and the structuring of communities. Enemies can reduce host fitness differences and/or cause species specific mortality. Root parasitic fungi (RPF) have recently received considerable attention as main plant enemies to cause such changes in community dynamics. The present study aimed to test whether RPF could alter community structure by either of those mechanisms. To do this, experimental microcosms were created using plants and RPF species that naturally co-occur in semi-managed grassland. It is hypothesized that the loss of carbon driven by root parasitic fungi could modify the competition outcome of developing plant communities. Additionally, given the parasitism effects seem to depend strongly on environmental conditions and biotic interactions; it tested whether the effect was modified depending on soil type (resource poor soil vs. normal soil) and when the fungi are all present in the microcosm. Results indicate that the fungal isolates used in this experiment had positive, neutral or negative effects depending on conditions where the plants were grown. There was a general trend in the frequency of positive and negative effects depending on stress conditions imposed to the plants. It seems that under the resource-poor soil (high stress conditions) indirect positive effects are more likely to show up; while less stressed plants seem to suffer more negative effects. It is speculated that such positive effect are indirect and driven by fungal mineralization given the ability of the fungi to grow saprophytically. Negative effects were on growth, rather than mortality, and show a level of differential host impact. For two grass species used in the experiment, parasitism seems to increase fitness differences while the dicotyledonous plant escapes from most negative parasitic effects.

Session 16 - Impacts of climate change on terrestrial and aquatic ecosystems

Chairs: Dietmar Straile, Kirsten Thonicke

O1 - The Inter-Sectoral Impact Model Intercomparison Project ISI-MIP

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ISI-MIP is a community-driven modelling effort with the goal of providing cross-sectoral global impact assessments driven by consistent climate and socioeconomic input data. The project is lead by the questions: What is the difference between a 1.5°C, 2°C, 3°C, and 4°C world and how good are we at telling these differences? More than 30 modelling groups participated in the initial fast track phase by providing global impact projections for the water, biomes, agriculture, health and infrastructure sector based on the newly developed climate [Representative Concentration Pathways (RCPs)] and socio-economic [Shared Socio-Economic Pathways (SSPs)] scenarios. The next phase is planned to include other sectors and regional models to create a more comprehensive picture of climate change impacts. We will present the concept of the project as well as first results of the Fast Track phase with a focus on cross-sectoral interactions.

O2 - Climate change impacts on terrestrial Natura 2000 habitats: Distribution, diversity and conservation options

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The primary objective of the European Habitats Directive is to preserve a 'favourable' status of selected species and habitats. In the face of climate change this may become increasingly challenging.

Here, we assess the climate change sensitivity of terrestrial habitat types listed in Annex I of the Habitats Directive on a European scale, using environmental envelope modelling, i.e. we apply the techniques of species distribution modelling to habitats. Furthermore, the current and projected future spatial habitat type diversity was evaluated. In addition to climatic variables, we integrated spatial information on land use and soil. We considered three time spans, three emission scenarios, and nine modelling algorithms, respectively.Habitats or more precisely the modelled environmental suitability of the habitats react differentially to climate change. Bogs, rocky habitats, grasslands, and some forest types are projected to lose suitable area. Of these, bogs and rocky habitats are projected to even lose under the unrealistic assumption of no restrictions in tracking suitable environmental conditions. Other habitats, in particular scrublands, are projected to gain additional area, and some habitats appear remarkably inert. Terrestrial habitat type diversity is partly shifting towards mountain regions. A decrease in habitat type diversity is projected especially for France, whereas habitat type diversity in eastern parts of the EU is projected to increase under future conditions.

We conclude that modelling potential climate-driven threats to habitats can assist in detecting particularly affected areas and habitats. Adaptation strategies of the protection area networks are required, including measures at the network scale as well as pinpointed management for preserving or supporting specific habitats.

O3 - Bridging the gap between species and community level approaches sheds new lights on biodiversity responses to climate changes.

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While the impact of climate change on biological diversity is now well documented on every biomes and in almost all major taxonomic groups, disentangling the evolutionary, ecological and physiological processes involved remains challenging. In the one hand, many studies have produced indices that represent changes in functional aspects of communities under global changes. On the other hand, other studies have rather focused on species-specific traits contributing to species responses. Although being complementary, each of these approaches cannot provide an integrated framework to study global change impacts on biodiversity. Community approaches mask individual species responses, while whether and how species-scale responses are translated to community dynamics is hardly considered. Thus, bridging the gap from community to species level represents an innovative way to shed new lights on the processes underlying these responses. Here, I will present a flexible framework which allows to study how species and community levels interact in this context. Using data from the French breeding bird survey, we first showed how the modeling of the temporal trend in Community Temperature Index (CTI, that directly reflects the balance between low- and high-temperature dwelling species of a community) can provide informative results about bird community response. I will then show how one can move from this community level approach to a species level approach in quantifying species-specific contributions to the temporal trend of CTI.

O4 - A collaborative project to assess the impacts of climate change on population trends

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Understanding variation in species response to climate change will help determine which communities and ecosystems are most at risk. In this project, we are forming a network of data owners with long-term population data sets collected on any taxonomic group in Central Europe. In collaboration with data owners, we will investigate the role of species traits (ecology, morphology, physiology, life history) in explaining variation in population trends among species. This approach will allow comparison of the population trends of a broad range of species in different habitats and realms. Importantly, relationships between traits and population trends may reveal the processes driving population trends. Thermal niche can be expected to mediate the direct impacts of changing temperatures due to climate change. Traits such as habitat breadth, diet breadth and dispersal ability can be expected to influence how well species cope with environmental change. We present results of our analyses of long-term terrestrial data sets. Data owners from institutions in Germany and elsewhere are already involved but the project is still open to further collaborators joining.

O5 - Latitudinal shifts in species interactions interfere with resistance of southern bog plant-communities to climate change

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The persistence of species under changed climatic conditions depends on adaptations, plastic responses and on biotic interactions at the local scale. Especially, populations at species' range-

margins may be crucial in containing a gene pool comprising adaptations to extreme climatic conditions.

Many species of northern European bog ecosystems reach their southern lowland range-limit in Central Europe. In a common-garden experiment, we assessed the impact of projected climatic changes on five bog-plant species (including *Sphagnum magellanicum*) sampled along a latitudinal gradient of 1400 km from Scandinavia to the marginal lowland populations in Germany. Populations were cultivated in monocultures and experimental communities composed of all five species from their local community and exposed to three climate treatments in a southern common garden.

Whereas most monocultures showed decreasing biomass production from southern to northern origins under southern environmental conditions, we observed within the more diverse experimental communities an increasing biomass production towards northern origins together with a shift in interspecific interactions along the latitudinal gradient. While dominance effects prevailed in southern communities, higher net biodiversity effects were observed in northern subarctic communities. Based on microsatellite analyses, the observed shift in biodiversity effects is discussed in the context of genetic differences between populations.

The combined effects of climate treatments increased biomass production in monocultures but not in diverse experimental communities, where overall the treatments did not result in significant effects. In southern communities, however, water-table fluctuations significantly decreased biomass production. Shifting interspecific interactions caused pronounced responses to changed climatic conditions in wetland communities of temperate southern marginal, but not of northern subarctic origin.

O6 - Multi-factor climate change effects on plant-herbivore and above-belowground interactions

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Several recent experiments have shown that climate change drivers may affect interactions among organisms, such as herbivory or above-belowground interactions. However, many studies focused on single climate change drivers such as drought or elevated CO_2.
Here, we present novel results from a multi-factor climate change experiment on (1) plant-herbivore interactions (Scherber et al. 2013) and (2) above-belowground interactions (Stevnbak et al. 2012). In

a split-plot experiment comprising 48 plots, we independently manipulated atmospheric CO_2 concentration, drought and air temperature in a FACE facility ("Climaite" experiment) near Brandbjerg (Denmark).

We show that combinations of three climate change drivers may lead to more complex outcomes, potentially affecting predictions of future herbivore impact or soil fertility under climate change. While elevated CO_2 and drought most strongly affected the observed interactions, we provide evidence that the number of climate change drivers (and not just their identity) affects organism interactions under future climatic conditions.

References:

C. Scherber *et al*. (2013) Multi-factor climate change effects on insect herbivore performance. **Ecology and Evolution**, doi: 10.1002/ece3.564

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O7 - Predicting community responses to environmental change

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Anthropogenic perturbations such as CO_2 emissions, eutrophication, species extinctions/introductions, or land degradation, strongly impact ecological systems. For effective prevention, management, and mitigation it is vital to make accurate predictions about the response behaviour of ecological systems to these changes.

We present an ongoing project that investigates the predictability of a community's response to resource enrichment, such as eutrophication, (abiotic environment) and species loss (biotic environment). In this project, we examine various influences that improve or hamper predictability. To make predictions about future dynamics and states, it is essential to have estimates about the interaction strengths between the community members. We apply four different approaches to estimate interaction strengths and test for their potential to improve accuracy of predictions:(1) experimental manipulations of a community, (2) systems modelling, (3) energetic modelling, and (4) observation of feeding rates.
We present first results from community manipulations (resource enrichment) as well as systems and energetic modelling. As experimental systems, we used communities of protists (ciliates) and

bacteria. Parameter values of interaction strengths for both types of models were derived from the community experiments. Model simulations showed that predictions about the transient dynamics in response to the perturbation made by the systems modelling approach were more accurate than the ones made by the energetic model. The opposite was true for the steady-state behaviour. We refer this to the fundamentally different assumptions of both approaches. Systems modelling includes functional responses that can be nonlinear and complex, whereas feeding rates in energetic models always describe a simple, linear relationship. Thus, one would expect the system modelling approach to perform much better in the transient, highly dynamic phase of the response.

From the results we have so far, we conclude that systems modelling is the primary tool of choice for predicting community dynamics, especially, since steady states (an assumption inherent to energetic models) are unlikely in natural systems. Further, we suggest that a combined approach of systems modelling together with parameter values derived from the upcoming feeding experiments will result in the highest predictability attainable by the four approaches presented.

O8 - Differentiation between native and invasive populations of a range expanding plant

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With global change many species are currently shifting or expanding their range. Some of these range expanding species become invasive in their new range. The mechanisms of invasion of these range expanders are largely unknown. Shifts in biotic interaction between the native and expanded range could potentially lead to invasiveness if, for example, species are partly released from their natural enemies. Potential differences in biotic interactions could lead to rapid evolutionary change in the new range, such as lower defenses against herbivory and enhanced growth (EICA) predicted for classic invaders from other continents. Here we investigated differentiation in growth and defenses between native and invasive populations of a range expanding plant, *Rorippa austriaca* (Brassicaceae). *R. austriaca* originates in South-East Europe but has spread to North-West Europe where it has become invasive. Glucosinolates are typical defense compound in this species. Populations differed significantly in their glucosinolate concentrations but there was no strong difference between native or invasive populations. In a reciprocal transplant experiment at three field sited we tested the effect of herbivory on the performance of 7 invasive and 5 native populations. Two sites were in the invasive range and one in the native range. Plants were caged individually to determine the effect of herbivores. Herbivory reduced the biomass of most populations at all sites. The effect of herbivory was least strong on the native plants at the native site, suggesting adaptation to native herbivores. Independent of herbivory, invasive populations grew much bigger than the native plants, which was consistent over all sites. As we found no overall lower defenses in the invasive population, the enhanced growth is not likely to be due to a trade-off

with lower investment in defenses. Further experiments are needed to explain this observed pattern. We are currently investigating molecular genetic relatedness between native and invasive populations of this range expanding plant. We are also using metabolomics analyses to further investigate shifts in defense chemistry and links to this to the genetic differentiation.

O9 - Genetic responses to 17 years of simulated climate change in an intact limestone grassland community

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We know little about the extent to which adaptation by natural selection will allow populations to persist *in situ* through climate change. These adaptive responses are potentially important, as they may play a key role in mediating the resistance of ecological communities to environmental change. At Buxton climate change impacts laboratory (BCCIL) semi-natural grassland has been exposed to more than 17 years of simulated climate change. The grassland has proven to be remarkably resistant to these treatments, changing little in species composition. We asked whether populations of four coexisting plant species have adapted to simulated climate change (summer drought treatment) within grassland plots at BCCIL. We found that populations of some (but not all) species have made genetic adjustments in phenotype in response to 17 years of simulated summer drought. In some cases, these responses to climatic selection were modified by fine-scale edaphic heterogeneity present within the grassland. Our results suggest that genetic responses have contributed to the observed resistance of this grassland to simulated climate change.

O10 - Planktonic host-parasite dynamics across time

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Parasitism is largely overlooked in ecosystem research, which is surprising given that about 40% of all known species live parasitically. Hardly any long- term datasets document how host-parasite dynamics change over time and under global change conditions. In Lake Maarsseveen (NL), the spring-bloom diatom *Asterionella formosa* has had a history of regular, high prevalence parasite epidemics by the chytrid fungus *Zygorhizidium planktonicum*, but in recent years that pattern has become less regular. Thanks to a dataset of 30 years of (intermittent) monitoring of host spring-

blooms and parasite epidemics, we could show that this loss of epidemics was related to the increase in winter temperatures. In colder winters, when the water temperatures drop below 3°C, *Asterionella* profits from a window of disease-free growth and develops a bloom, as the parasite is still inactive. As the water warms up later in the season, the parasite becomes active, finds the host blooming and can develop an epidemic. In warmer winters, the parasite remains active and continually infects the host, which allows other diatom species to bloom. Hence, climate change can affect host-parasite dynamics and thereby the species succession and subsequent food web structure in lakes.

O11 - Climatic forcing of plankton dynamics: from the global ocean to freshwater mesocosms and back

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Lakes and oceans are characterized by pronounced vertical gradients in physical conditions (e.g. temperature, turbulence) and in resource supply (e.g. light, nutrients), which vary geographically and change seasonally under climatic forcing. These vertical gradients influence species interactions in the plankton and, ultimately, control ecosystem processes such as primary and secondary production, nutrient recycling and carbon storage/emission. In this talk I discuss impacts of abiotic climatic drivers on plankton dominated systems from a trophic-dynamic perspective. I progress from explaining relatively simple equilibrium responses of phytoplankton, light and nutrients to different stratification and mixing scenarios to the description of transient and unstable dynamics (such as seasonal blooms and phytoplankton-grazer oscillations)involving more complex biotic feedbacks. My emphasis will be on theoretical concepts and fundamental principles, but empirical evidence, especially from carefully designed field experiments, will be amply discussed.

O12 - Regional patterns and long term trends of air temperature and surface temperature of drinking water reservoirs in Germany

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Monthly means of air temperature (TA) from 60 DWD-stations (1975 – 2011) and long term observations (1993 – 2011) of surface water temperatures (TS) of 28 German drinking water

reservoirs situated in Baden-Wuerttemberg, Rhineland-Palatinate, North Rhine-Westphalia, Lower Saxony, Thuringia, and Saxony are evaluated for regional temperature patterns and temporal trends. Highly significant multiple correlations between TA and geographical parameters (longitude LONG, latitude LAT, altitude ALT) were used to develop a model that allows estimating average monthly and annual means of TA for each geographical location in Germany. It helps to fill the gap of frequently missing historical weather observations directly at water bodies. Temporal trends (1975 – 2011) of monthly TA-means depend as well but monthly heterogeneously on LONG, LAT, and ALT. Qualitatively similar results can be expected and were found for TS, which closely correlates with TA. Western reservoirs are warmer in the winter half-year and slightly colder in summer. Additional to the impact of geography, surface area SA and volume VOL of the reservoirs significantly influence the seasonal TS-development. Large SA accelerates warming in spring and cooling in autumn, large VOL has opposite effects. If the observed TS-trends perpetuate, remarkable consequences for the seasonal mixing and stratification conditions and, finally, for water quality and reservoir management have to be taken into account. This will be exemplified based on results of ecological long-term research at the Saidenbach Reservoir.

O13 - Climate warming impacts on phenology changes across three trophic levels

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The disruption of food-web interactions is one major concern of future global warming. In aquatic food webs phenologies of primary producers, herbivores and of top consumers (fish) have been shown to be strongly related with annual variability in water temperatures. We use such relationships in combination with hydrodynamical modeling to predict a) changes in the phenology for algae, Daphnia and whitefish and b) changes in the differences of their phenological responses (changes in match/mismatch) under constant and season specific (November versus April) as well as within-season specific (March versus April) warming. We show that the effect of constant warming on phenology differences is small compared to interannual variability in phenology differences. Furthermore, our simulations suggest that more emphasis should be placed to the study of within-season specific warming effects on the match/mismatch of trophic interactions.

O14 - Phenological and ecological consequences of changes in winter snowpack

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Melting of snowpack in spring is an important seasonal event at high altitudes because it sets the beginning of the growing season, and thus the phenology of plant growth and flowering, and availability of these resources for animal consumers. At our study site at 2,900m in the Colorado Rocky Mountains, snowmelt now averages two weeks earlier than in 1975, from a combination of lower snowfall , dust storms, and warmer spring temperatures. There is also a trend of increasing annual precipitation falling as rain instead of snow.

We have monitored flowering phenology and abundance for about 100 species of plants in permanent plots since 1973, and use this record to look at how the change in timing of snowmelt has affected flowering. There is significant variation among years in flowering phenology (e.g., about six weeks difference between 2011 and 2012), with a mid-season decline in flower abundance becoming apparent with the earlier growing season. The date of the last frost has not been changing in concert with the earlier growing season, consequently many species now develop flower buds that are then damaged or killed by frost. Without seed production, the demography of some plant species is likely being affected.

Some animal species are also being affected by the changes in length and temperature of winter. New species of mammals, birds, and insects have begun to reproduce and overwinter at our field site in the past decade, and hibernators have changed the phenology of emergence from hibernation. Interactions among species such as pollination and seed predation have also been affected by the changes in snowpack and phenology. For example, although both migratory hummingbirds and their floral resources are changing phenology, they are not changing at the same rate, leading to mismatches in their historical synchrony; hummingbirds now arrive well after their earliest food plant has begun to flower. A similar loss of synchrony appears to be affecting bumble bees as they emerge from overwintering underground, and one of their earliest nectar sources. Seed predators, and their parasitoids, are probably being affected by the absence of seeds from species sensitive to frost. Thus many aspects of high-altitude ecological communities are being affected by the ongoing changes in depth of winter snowpack and the timing of its melting.

O15 - Dynamics of fresh-water lakes in the light of global climate change: Increased CO_2 disables inducible defences in *Daphnia pulex*

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Ocean acidification is acknowledged to have a major impact on marine calcifying organisms and furthermore negatively affects anti-predator defences in marine fish species. Therefore, ocean acidification has an immense influence on marine ecosystem structures. With the predicted progression of global climate change not only marine waters are subject to acidification but also freshwater lakes could suffer from the effects of increasing CO_2 levels. We therefore examined water temperature, oxygen content and pH value for a period of 30 years in German freshwater lakes. We observed a continuous increase of the average water temperature, correlated with rising atmospheric temperatures. Furthermore, a negative trend of pH-values was detected. This data indicated that climate change might also impact freshwater lakes, which could have serious effects on ecosystems and biodiversity. Consequently, we performed a predation bioassay under elevated pCO2 conditions using the predator-prey interaction between the phantom midge larvae *Chaoborus* spec. and the freshwater crustacean *Daphnia pulex*. *D.pulex* was induced using different concentrations of *Chaoborus*-Kairomone combined with ambient and decreasing pH-values of 6.9 and 6.7 (achieved by CO_2 bubbling). Reduced pH-values resulted in a decrease of predator-induced morphological defences making *D. pulex* more vulnerable to *Chaoborus* predation. As *Daphnia* is a keystone species in freshwater ecosystems, acidification could have far-reaching effects.

O16 - Do phosphorus limitation and CO_2 levels interact to influence the CO_2 concentrating mechanism of *Chlamydomonas acidophila*?

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The extremophilic green microalga *Chlamydomonas acidophila* can accumulate inorganic carbon (Ci) and exhibits high affinity CO_2 uptake under low-CO_2 (air-equilibrium) conditions, similar to organisms with an active CO_2 Concentrating Mechanism (CCM), whereas both processes are down-regulated under high CO_2 (4.5% CO_2) conditions. In addition, *C. acidophila* has a high affinity CO_2 uptake (low $K_{0.5}(CO_2)$) under both P-replete and P-deplete conditions, independent of CO_2 growth conditions, which contrasts with the assumption that a CCM is an active process. In this contribution we explored other aspects of a CCM in *C. acidophila* adapted to high or low CO_2 under P-replete and P-limited conditions.

Results reveal that *C. acidophila* expresses external CA and a constant CCM activity under all environmental conditions. The accumulated inorganic carbon concentration was highest under the low CO_2, P-replete condition. This implies that active inorganic carbon uptake is decreased under low cellular P status. The $K_{0.5}(CO_2)$ was lower under low than under high CO_2 conditions and rather insensitive to cellular P status. In conclusion, *C. acidophila* shows pronounced responses to CO_2 conditions and P concentration, of which some related to the strong proton gradient present under these low pH conditions.

O17 - Climatic drivers of range-wide variation in the demography of serotinous South African (Fynbos) Proteaceae

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The balance of reproduction and mortality determines whether population growth is positive or negative. An understanding of climate effects on reproduction and mortality, which ultimately represents population growth, is essential for predicting how global change will alter the abundance and geographical distribution of species. Here we study how climate and fire history affects reproduction and mortality across the geographical range of plant species in the South African Cape Floristic Region (CFR). The CFR, a global biodiversity hotspot of conservation priority and a fire-prone Mediterranean-type shrubland, is dominated by the diverse Proteaceae family that forms an important part of the region's biodiversity. Proteaceae are taxonomically, ecologically and geographically well-studied and used as model organisms for biodiversity research and an indicator group for conservation in the CFR. Demography within this plant family is approached with renewed interest because of the need to understand the dynamics of species under global change. In light of this, we assembled a dataset that describes how demographic rates (mortality, fecundity, recruitment) vary across more than 2500 populations of 25 Fynbos Proteaceae species. Our study populations were located along major environmental gradients and the study species represent a wide range of life histories and growth forms. Results presented here focus on quantifying and explaining range-wide demographic variation of serotinous Fynbos Proteaceae with respect to fire history and climatic variation. This research will not only improve our understanding of current species distributions but will also provide insight into the reshuffling of species under global change.

O18 - An individual-based model for simulating vegetation dynamics at the tree line in Siberia

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Due to climate change temperatures in the Arctic are increasing. In response, the geographical position of the tree line shifted further north, replacing vast tundra areas. This tundra-taiga transition decreases the albedo, which can fuel the increase of temperature at least locally. However, there are major uncertainties in predicting the reaction speed of the tree line advance due to complex interactions of processes determining tree stand dynamics. Hence, an individual-based and spatially explicit model was developed representing each life history stage of larches explicitly.

Incorporated processes were adapted to represent observed patterns of tree stands in order to achieve a most realistic model. A thorough sensitivity and uncertainty analysis of the model supported the credibility of its results. Sensitivity values were overall small with highest values found for spatial patterns of emerging stands. Finally, forced by an assembled weather time series the model was able to produce tree stands, which were similar to field observations, in terms of age distributions, densities and spatial patterns. Thus, if this model will be applied to a large area spanning the tree line it can be an adequate tool for answering questions about the future movement of the tree line.

O19 - Intraspecfic differences in responses to rainshelter-induced drought and competition of *Fagus sylvatica* across Germany

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It is inevitable that the predicted changes in temperature and precipitation (IPCC 2012) will affect European forest ecosystems. Depending on the region the decrease in summer precipitation might amount between 15% and 50%. With the main objective to assess the combined effects of drought and competition on *Fagus sylvatica* recruitment, we set up a large rain shelter experiment on three sites across a gradient from northeast to the southwest of Germany (Schorfheide-Chorin, the Hainich National Park and Schwäbische Alb). Saplings of different beech provenance regions (Brandenburg, Mitteldeutschland und Schwäbische Alb), which correspond to the different experimental sites, were planted in natural forests in a total of 45 rainshelter plots in three different regions with the same number of control plots. The main question is whether such drought conditions are differently tolerated by certain genotypes of species which can cope with such conditions, possibly through pre-adaptation.

For the microclimatic conditions beneath the roofs, our first results show that the temperature and the air humidity were not affected by the roofing. We found significant effects in soil humidity between the treatments. The upper soil layers are stronger affected than the deeper soil layers. There was no indication of local adaptation of the beech saplings. Site seems to have the largest impact on plant performance. For the physiological performance (transpiration) of the plants we found clear roofing effects. These effects also depend on site identity and competition. On the basis of the instrumental observation, we found differences between the two precipitation treatments. The sheltered plots showed a reduction in the soil water availability while air moisture and air temperature are relatively unaffected by the sheltering.

As a short term reaction we found general reduced transpiration. This can be seen as an immediate reaction on drought. Growth parameters were affected lesser by drought than by site and competition. This was expected, because the growth reaction on drought inevitably needs more time. The weak long term effects of the drought conditions on growth rates are explainable by the limited time of the treatments. However, since the experiment will be continued for one year, we expect growth rate effects to become clearly visible over that time.

O20 - Effects of drying wetting cycles on soil and plant C and N dynamics

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Climate change scenarios for the Iberian Peninsula predict more extreme precipitation regimes with larger rain events and longer intervening dry periods, potentially affecting ecosystem C and N balances. The "Birch" effect, a phenomenon of high soil C and N losses after rewetting of dry soils could become more influential under these circumstances. Additionally, different drought susceptibility of C and N cycles might cause asynchronicity between productivity and mineralization.

We conducted a large-scale water manipulation experiment in an open oak savanna in Portugal to study the effects of changing rainfall patterns on soil C and N cycling and understorey productivity.

Our results showed that extending the dry period between precipitation events from three to six weeks had no effect on productivity and community structure, this lack of responsiveness being attributed to phenotypic and physiological adaptations of the vegetation. "Birch" effects were only moderate with no significant treatment differences in the C-losses during observed pulse events, while N-leaching was potentially higher in the 6-weekly watering treatment. Nevertheless, rainfall manipulation did not affect soil N dynamics, with nitrogen being limiting in both treatments. In comparison, non-manipulated control plots experienced a severe natural wintertime drought, significantly reducing productivity and affecting species composition, but showing less evidence of N limitation. Drought effects on productivity were stronger than on mineralization, which resulted in increased soil and tissue N concentrations in the control plots as compared to the watering treatments. However, in the control plots negative effects of a potential asynchronicity between productivity and mineralization were not observed, as water was a stronger limitation of productivity than N availability. Our results highlight the necessity for further studies investigating how climate change will influence the co-limitation of water and N availability, which in turn might affect plant productivity in Mediterranean systems.

O21 - The role of ocean warming in the decline of kittiwakes in Norway

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Population dynamics of seabirds can be rather sensitive to climatic and oceanographic conditions. Climatic fluctuations may affect population dynamics both via reproduction and survival. More than 25% of the European population of black-legged kittiwake (*Rissa tridactyla*) nest in Norway. However, the Norwegian population has been declining drastically during the past decades, and is now listed as endangered in the Norwegian Red List.

Using long-term population data from five Norwegian breeding colonies, we investigate which role the oceanic climate plays in the decline. We applied stochastic population modelling in order to explore the effect of changing sea surface temperature on kittiwake population dynamics. We found that the colonies differ in their specific responses to climate spatio-temporally as well as in terms of life-history stages affected and variances explained. However, the slopes estimated are negative in all colonies, indicating population decreases in warmer years.

Based on population viability analyses and warming scenarios, we estimated extinction probabilities of the colonies. The projected warming trends during the next century significantly increase extinction risks of all colonies investigated.

O22 - Bird species richness along elevational gradients: direct and indirect effects of climate, vegetation and resources

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A commonly observed pattern in bird species richness along tropical elevational gradients is a unimodal distribution with maximum richness at intermediate elevations. Although it has been proposed that bird species richness is mainly driven by a combination of temperature and water availability, it remains unclear whether these factors influence species richness directly by physiological limitations or indirectly through changes in habitat structure and resource availability.

We used point counts to assess bird species richness at 30 sites in six near-natural habitats along an elevational gradient (870 - 4550 m) at Mt. Kilimanjaro, Tanzania. We recorded several abiotic (temperature, precipitation) and biotic variables (vertical vegetation heterogeneity, biomass of invertebrate prey, fruit abundance) and used structure equation modeling to study their direct and indirect effects on bird species richness. As expected, we recorded the highest bird species richness at mid elevations. Climate affected birds mainly indirectly through vertical vegetation heterogeneity and resource availability. Vertical vegetation heterogeneity influenced bird species richness both directly and indirectly through resource availability. The effect strength of fruit abundance and invertebrate biomass increased substantially when considering only frugivorous and insectivorous bird species, respectively. These results suggest that changes in temperature and water availability influence bird species richness mainly indirectly via changes in habitat structure and guild-specific food availability. We conclude that effects of climate change in tropical mountain systems are difficult to predict because bird species richness rather depends on direct effects of habitat structure and resource availability and only indirectly on climatic factors.

P1 - Effects of fertilization and advanced aphid occurrence in spring on a grass-endophyte association

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A phenological shift of interacting species due to climate change can disrupt interactions, when one partner shifts faster than the interacting partner. Thereby we assume that short-lived species or species with short generation times, like aphids react faster than long-lived species, like perennial plants. Effects of possible phenology shifts of an herbivore on an endophyte-plant relationship have not been studied. In late spring we simulate an advanced occurrence of aphids (*Rhopalosiphum padi*) on their secondary host plant (*Lolium perenne*), which is either infected with an endophytic fungus (*Neotyphodium lolii*) or uninfected. Aphid and predator abundances will be weekly recorded on each plant until the end of the season. We expect (1) that host plants with earlier aphid occurrence show lower fitness compared to plants with natural colonization, (2) higher fitness of plants with an endophyte infection and (3) that fertilization and earlier aphid occurrence lead to changes in the chemical compounds produced by the endophyte-grass association. In preliminary analyses we showed that the concentrations of the alkaloid Peramine changes with the age of the host plant.

P2 - Warming-induced disruption of ectotherm food webs

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Climate change may strongly affect aquatic ecosystems, with warming intensifying feeding links in ectotherm food webs. However, it is unclear how temperature-mediated shifts in the combined forces of competition and predation will affect the fate of species that function at different trophic levels in pelagic food webs.

Studying a tri-trophic planktonic food web we focused on the relative importance of predation and competition in determining extinction rates at 15°C and 25°C. We found that an elevated temperature dramatically increased extinction rates under predatory overexploitation by the carnivore, whereas rates of competitive exclusion among herbivore species were not increased by warming.

Our results indicate that warming of temperate ectotherm food webs may lead to enhanced boom-bust dynamics that entail increased risks and rates of local extinction, reinforcing the need of appropriate management strategies to protect and maintain European's aquatic biodiversity and ecosystem services.

P3 - Impact of climate change on shallow lakes metabolism: Space for time approach in a mesocosm experiment across a North / South European gradient.

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Shallow lakes are recognised to play an active role in the global carbon cycle. However, to which extent and under what circumstances, they act as carbon source or sink is still debated. Whether a shallow lake acts as a source or a sink of C is largely determined by the relative importance between gross primary production (GPP) and respiration (R), which in turn are influenced by the nutrient status, the light regime and the food web structure of the system. The variables are influenced and constrained by climate, most notably water temperature and precipitation. In the light of the anticipated climate change, it is therefore important to understand how GPP and R will be influenced by climate and how climate change will affect the global carbon cycling. Within the EUFP7 project REFRESH we conducted a mesocosm experiment in 6 European countries over 6 month, spanning a climatic gradient from Sweden to Greece. In these mesocosms we analysed metabolism and carbon flux under two nutrient (25 µg TP/L and 250 µg TP/L) and depth (1 m and 2 m) regimes. Most mesocosms acted as a sink of carbon; however, we found significant differences between the two nutrient levels and between depths, most notable differences were in the southern countries. Particular in the beginning of the experiment mesocsoms at higher temperature acted as sources, which was slightly amplified under low nutrient conditions.

P4 - Aspects of the CO_2 concentration mechanism in 3 green microalgae

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The CO_2 concentration mechanism (CCM) consists of active processes dependent on cellular ATP and thus on cellular P status. In this contribution we compared some aspects of the CCM of three species of green algae, assumed to have different CCMs

We grew the algae in a range of external pH conditions ranging between pH 1 and 10. Results show that *C. acidophila* is a typical acidophile with an optimal growth rate at pH 3, whereas, *Chl. emersonii* is a typical neutrophile with a maximum growth rate between pH 8 and 9. Although tolerating acid pH, *C. pitschmannii* had a wide pH preference ranging from pH 3 to pH 8. Rubisco kinetics experiments performed on these cultures suggest that the Km(CO2) in *Chl. emersonii* and in *C. acidophila* were higher than that in *C. pitschmannii.*

The algae were cultured under P-replete and P-limited conditions and pH drift experiments were performed. These experiments revealed that *C. acidophila* relied solely on CO2 uptake, whereas we found the opposite behaviour in *Chl. emersonii*, which was also able to use HCO3- as a carbon source for photosynthesis. The final pH in the drift experiments was slightly decreased under a P-limitation in *C. acidophila* and *C. pitschmannii* suggesting that cellular P status influenced inorganic carbon utilization in these species.

P5 - Impacts of climate change on long-term dynamics of physicochemical parameters of selected dams in Sauerland, North Rhine-Westphalia, Germany

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Rising carbon dioxide (CO_2) emissions and other greenhouse gases cause an anthropogenic greenhouse effect, which is hypothesized to be responsible for the observed increase of global temperatures. Furthermore, ocean surface temperatures increase and rising CO_2 levels cause ocean acidification. The change of marine physical and chemical parameters significantly impacts marine ecosystems. Whereas research on the impact of climate change on marine systems has intensified over the past decade, it is not known whether freshwater systems also suffer from global climate change. We here determined how physicochemical parameters of climate change influence the freshwater dams in Sauerland, North Rhine-Westphalia, Germany change with climatic conditions.

We examined water temperature, oxygen content and pH value for a period of 30 years. We observed a continuous increase in the average water temperature, which is directly related to rising atmospheric temperatures. As a consequence, we observed a steady decrease in the oxygen concentration. Furthermore, a negative trend of pH was detected.

Data obtained from long-term monitoring indicate that climate change might also impact freshwater lakes, which could have serious effects on ecosystems and biodiversity.

P6 - Variability structure of lake water temperature at different temporal scales: from decades to days

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Climate change is often communicated in terms of mean values, such as temperatures averaged over months or years. However, the same average temperature change can derive from a multitude of warming patterns from sub-daily to decadal temporal scales. As mean changes are not experienced by ecosystems, these are inadequate measures of the changes that organisms actually experience. For example, low and high frequency variations may affect ecosystem components in very different ways. We analyse long-term, high-frequency records of water temperature at different temporal scales (from decades to daily measurements) and detect patterns in their variability structures in order to identify relevant time scales of variability. The overall goal is to determine in what ways the detailed seasonal patterns of observed climate warming affect the physical and biological structure of lakes.

P7 - Holocene reconstruction of vegetation and climate at the arctic tree line, Eastern Russia

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This investigation presents one long-term vegetation and climate reconstruction from the forest line in Arctic Siberia. Quantitative reconstructions of Holocene vegetation and climate are essential for our understanding of current processes and for evaluating simulations. The Arctic ecosystem is highly sensitive to climate variations. This has been pointed out for example in the Arctic amplification debate, or by the observed temperature increase and northward movement of tree and shrub species over the last decades. This presentation shows a reconstruction covering the last 8,000 years based on the pollen analysis of one lake archive south of the Taymyr Peninsula, which is located at the present arctic forest line. We present quantitative estimates of past regional plant abundances of main tree and shrub species, e.g. *Betula nana* and *Larix gmelinii*, based on the REVEALS model calculations. We also reconstruct the regional summer temperature and annual precipitation using a pollen-climate transfer function. In conclusion, these results show a change from boreal forest to shrub tundra vegetation after the end of the Thermal Holocene Maximum and indicate moderate Holocene temperature deviation from modern values, which did not exceed ~2°C.

P8 - sDiv - The Synthesis Centre within the new German Centre for Integrative Biodiversity Research

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One of the central missions of the **German Centre for Integrative Biodiversity Research** (**iDiv;** www.idiv-biodiversity.de) is the promotion of **theory-driven synthesis** and **data-driven theory** in biodiversity sciences. It is located in the city of Leipzig and jointly hosted by the Martin Luther University Halle-Wittenberg, the Friedrich Schiller University Jena, the University of Leipzig, and the Helmholtz Centre for Environmental Research – UFZ. It is supported by the Max Planck Society, the Leibniz Association, and the Free State of Saxony.
The four overarching *iDiv* questions of biodiversity science are:

(1) How can we detect and quantify biodiversity ("detection")?

(2) How does biodiversity emerge ("emergence")?

(3) What are the consequences of biodiversity for the functioning of ecosystems ("consequences")?

(4) How can we safeguard biodiversity ("conservation")?

Embedded in an active research environment, the Synthesis Centre for Biodiversity Research, sDiv, offers **national and international workshops**, **postdoc positions** and a **sabbatical programme** to foster theoretical and synthetic thinking. sDiv will boost scientific developments in this young discipline by bringing together researchers from different projects and disciplines as well as providing conditions that promote the creative process.

Here, we present some key characteristics of sDiv and iDiv in their unique combination of a research and a synthesis centre.

Session 17 - Ecophysiology of plants: bridging between methods and scales

Chairs: Günter Hoch, Ansgar Kahmen, Jürgen Kreyling

O1 - Plant responses and resistance against slugs and snails

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Although slugs and snails play important roles in terrestrial ecosystems and cause considerable damage on a variety of crop plants, knowledge of the mechanisms of plant immunity to molluscs is limited. We found slugs to be major herbivores of *Arabidopsis thaliana* in nature and therefore investigated possible resistance mechanisms of this species against several molluscan herbivores. Treating wounded leaves with the mucus residue ("slime trail") of the Spanish slug *Arion lusitanicus* increased wound-induced defense responses, suggesting the presence of defense elicitors in the slime. Using mutant *A. thaliana* plants with genetically altered traits allowed to study the role of resistance pathways against slugs and snails. Slugs and snails were found to exhibit nocturnal activity, which correlated with higher levels of plant defense metabolites during the night.

Our data highlight the function of anti-herbivore defense pathways in resistance against slugs and snails and suggest an important role for the diurnal regulation of defense metabolites against nocturnal molluscan herbivores.

O2 - The effect of drought on peppermint secondary metabolites

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Peppermint is an essential oil rich plant having its usage in food, cosmetic and pharmaceutical industry. Because of limited carbon assimilation during drought, plants change their resource allocation into secondary metabolites. Drought can thus influence plant resistance to biotic and abiotic stresses. Our aim in this present study was to investigate qualitative and quantitative changes induced by water limitation in stored and emitted secondary metabolites namely biogenic volatile organic compounds (BVOCs), stored terpenes and flavonoids. In leaf and root tissue we also measured C:N ratio and delta ^{13}C. In order to study secondary metabolites under drought we performed a greenhouse experiment with 45 peppermint plants (*Mentha x piperita*) grown under three irrigation treatments (control, mild drought stress and severe drought stress). Mild and severely drought stressed plants received for 30 days 50% and 20% of irrigation used for control plants. Decreased amount of irrigation caused 20% and 38% reduction of aboveground biomass of mild and severe stressed plants, respectively. Emissions of BVOCs namely aldehydes (Nonanal, n-Heptanal, Octanal) were significantly higher in severely drought stressed plants. The monoterpenes did not follow any water deficit trend except for significantly higher limonene and significantly lower beta-pinene emissions under severe drought. The ^{13}C isotope signature of leaves was treatment specific and corresponded with individual drought levels. The C:N ration was significantly low in mild as well as in severe drought treatment. The world production of the peppermint essential oil (different species from the genus *Mentha*) reached 23 000 t per year. In most countries peppermint has to be irrigated to sustain high yield of essential oil. This study reveals changes in peppermint secondary metabolisms under drought and delineates possible climate change impact on the peppermint production.

O3 - Does diversity matter? Advances in nutrient cycling in grasslands indicated by 15N natural abundances

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Natural abundances of nitrogen stable isotopes in plant biomass can be used to trace the response of plants and plant communities to abiotic and biotic factors, providing insights into the value of biodiversity for ecosystem functioning. Community biomass is commonly used as a proxy of ecosystem productivity and respective nutrient concentrations are measured to assess the nutritional status of grassland ecosystems. However, although the community biomass may be a useful integrator for the characterization of the overall ecosystem response to environmental characteristics and changes, studies on patterns of stable isotopes in temperate grasslands have been mostly restricted to an experimental setup and only few investigations analyzed the isotopic composition of the biomass of species communities present in the field.

Here, we present a study on soil and community biomass δ15N values from 150 grasslands from three regions in Germany. Grasslands were arranged along a gradient of increasing land-use intensity that represents large parts of the Central European grassland vegetation. To correct for plot-specific differences in soil δ15N values biomass "Δδ15N" values (δ15N plant - δ15N soil) were calculated. ANCOVA models were performed to analyze effects of soil type, land use, δ13C natural abundance, nitrogen in aboveground plant biomass, plant functional group abundance and plant species richness on observed δ15N and Δδ15N values. Results indicated that plant species richness was very closely related to δ15N and Δδ15N, even if all other factors were used as co-variables. Furthermore, it turned out that biomass of grasslands on semi-terrestrial soils was significantly enriched in 15N, assumingly due to enhanced uptake of 15N enriched ammonium. Land-use intensity and particularly fertilizer application significantly increased the 15N abundances. While the cover of legumes revealed no effect, grass cover negatively affected Δδ15N values significantly.

We conclude that decreasing Δδ15N values with increasing species richness brought field evidence for a more closed N cycle under higher plant diversity assumingly due to enhanced nutrient partitioning, while heavy fertilization is seen to provoke great losses of N via leaching or volatilization.

O4 - Functional traits- fixed facts or variable depending on season?

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Traits are widely used to detect and explain responses of ecosystem processes to climate and land-use change. Especially large-scale studies use trait data from databases, representing a great source of information for different traits and species on European and global scales. The problem of this approach is, however, that often only one value per trait and species is available in traitbases, neglecting the intraspecific trait variability.

One source of variability is the seasonal variability, which to our knowledge has not yet been intensively analyzed. Most handbooks for standardized trait measurements claim that traits should be measured at an "optimal" stage, which is typically defined to be reached when the plants are in full blossom. However, for practical reasons, traits are often measured in parallel to vegetation relevés, including also species that are not flowering - but is this method justified?

The main aim of this study is to quantify the extent to which species trait values vary with season and phenology. From April to October 2012, we monitored eco-physiological plant traits (LDMC, SLA, Fv/Fm, Performance Index PI, stomata density and size, potential conductance index PCI) weekly under controlled conditions in the Botanical Garden Regensburg of 15 summer green species. In parallel, we recorded phenological stages. Using this unique dataset, we could show that all traits largely vary throughout the year and partly with phenology and that these variations were strongly species specific. We could further show that species rankings do not remain consistent over time for none of the traits.

From this study, we concluded that the seasonal timing of trait measurements is crucial for the traits and that this aspect should be taken into account in upcoming studies.

O5 - Can frost hardiness explain plant species' distribution ranges?

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The aim of this study was to investigate the relationship between frost hardiness and the species' macroclimatic niche. While physiological frost hardiness reflects a major component of a plant species' fundamental niche, the macroclimatic niche represents the realized niche and can be derived from the species' geographical distribution range. We assessed frost hardiness and geographical distribution characteristics of 59 different herb and tree species from 19 families. Frost damage was investigated at the time of maximum hardening in winter on buds, needles or leaves. We hypothesized that frost hardiness of the different species is in accordance with their macroclimatic niche, in particular that the lower 1 %-percentile of winter minimum temperature of the coldest month in the distribution range corresponded to frost hardiness. Frost hardiness was tested in a climate test chamber by exposing the plant material to different freezing temperatures and was assessed by LT_{50}-values. In contrast to our expectations, we did not find any relationship between the LT_{50}-values and macroclimatic niche variables. Additionally, we related frost hardiness to the phylogeny of the investigated species. We found frost hardiness to be highly phylogenetically conserved. In conclusion, physiological frost hardiness is not a good predictor for a species' geographic distribution range, which has important implications for using minimum temperature in species distribution models.

O6 - Growing season length and low temperature co-control upper elevational range limits of deciduous tree species

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Low temperature is one of the most important factors that can exert the known overarching trends in species distribution of major European deciduous tree taxa along latitudinal and elevational gradients. Apart from low temperature, time could be an important constraint for tree species to complete growth and fully harden tissues in autumn before freezing temperatures in winter. Here we assessed the secondary growth of 8 broadleaved tree species over the 30 last years using tree cores collected along three elevational gradients in the Swiss Alps. We aimed at disentangling the effects of lower temperatures and shorter growing seasons on secondary growth along altitudinal gradients from lower elevations to the species' natural upper limits. The cores of a total of 421 trees were used for growth-ring analysis. Using mixed effects models, secondary growth was correlated with the date of bud-break predicted from a phenological model and growing season mean temperatures recorded *in situ*. First results suggested that growth of deciduous tree species is strongly influenced by growing season mean temperature as well as by the growing season length. Maximum growth across all species is reached at growing season mean temperatures between 13 and 15 °C and growing season lengths of 100 to 120 days (from the bud-break date to September 1). Growth strongly declines with colder temperatures and shorter growing seasons, whereby across all species temperature can compensate for short seasons to a certain extent. These results indicate that the elevational distribution limits of deciduous tree species are likely co-controlled by the growing season length and low temperature during the growing season.

O7 - Ecophysiology of tree regeneration at the alpine treeline

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Alpine treelines represent the altitude at which trees can no longer establish or grow, or have not had enough time to do so. Treelines occur worldwide on high mountains at altitudes with roughly similar mean growing season temperatures, suggesting a general principle. On the other hand, variation around the general mean is also considerable. If not caused by disturbances, regeneration failure is likely to cause the downhill deviations. Treelines also show wide variation in spatial structure and dynamics. Specifically the ability for tree cover to expand upslope following climatic warming appears to vary among treeline sites and/or species. Ecophysiological research that addresses the general principle behind global similarities currently focuses on growth limitations in adult trees. In contrast, we are addressing the principles behind the observed variation, focusing on restrictions for tree seedling establishment. We are experimentally studying the microclimatic dependency of seedling survival and growth for *Pinus cembra*, *Picea abies*, *Larix decidua* and *Sorbus aucuparia* at treeline in the French Alps. We will present the first results of this study, showing, among other things, the species-specific effects of shading and day and night warming on seedling performance. Results indicate an ambiguous role of the alpine vegetation, which on the one hand provides protection from the harsh alpine climate and on the other hand competes for resources and results in cooler conditions due to shading. Results also indicate the importance of water availability in determining warming effects. These and further results will contribute to a deeper understanding of treeline spatial patterns and allow better predictions of treeline responses to climatic changes

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O8 - Finding the low temperature threshold for growth in temperate broad-leaved trees

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In temperate climates, most tree species reach their upper limits at species-specific distances to the alpine treeline. Understanding the physiological mechanisms behind the cold limit of growth might be key to understand the natural distribution patterns of trees. We investigated the low temperature threshold for root-growth in seven deciduous tree species. Seedlings were grown for 18 weeks in insolated tubes, which lower halves were submerged in water baths. Water temperatures inside the baths were kept at either constant 2 °C or 16 °C. Hence, newly formed roots grew along a thermal gradient from greenhouse-temperatures (20 °C) at the soil surface to the respective water temperatures at the bottom of the tubes. Excavation of roots from the soil cores enabled the precise determination of the soil depth and its corresponding temperature, at which root growth stopped.

Warm treated seedlings produced roots down to the bottom of the tube, with no reduction in total root length or biomass in deeper soil horizons, whereas root production declined strongly in cold treated seedlings at soil temperatures below 10 °C. While the bulk of roots were produced at soil temperatures above 5 °C in all investigated species, some minor root growth was observed at lower temperatures, with the cold threshold differing among species (from 4.3 °C in *Fraxinus excelsior* to 2.3 °C in *Sorbus aucuparia*). This temperature threshold for growth correlates with the species' elevational limits, indicating a direct effect of growing season temperatures on the distribution ranges of broad-leaved trees. Most interestingly, roots produced near their cold limit exhibited a characteristic morphology, resembling less developed, young roots: across all species, they were largely unbranched, thicker, pale colored and of reduced mechanical robustness. The question, if these morphological changes are indicative of a key-process that becomes limiting at cold temperatures is topic of an upcoming project.

P1 - Comparison between single and multiple pest infestation on plant biochemistry and physiology

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Worldwide pests co-occur in crops but little is known about the effects of multiple pest infestations on plant response. Spider mites (*Tetranychus urticae*) and other piercing-sucking herbivores such as aphids (*Myzus persicae*) have long been studied. In addition to their economic impact, they both share certain traits (feeding behaviour, resistance to pesticides, and a huge variety of host-plants). Besides, they quickly reproduce and they can respond differently to biotic and abiotic factors. In the present contribution, we compared single versus multiple pest infestation under laboratory conditions by analysing fecundity and survival of both pest species on tomato (*Solanum lycopersicum* ´Ailsa Craig´), bean (*Phaseolus vulgaris*) and pakchoi (*Brassica rapa* var. *chinensis*). On the basis of the findings we assessed the effects of single and multiple infestations on the physiology and biochemistry of tomato plants (volatile and non-volatile metabolites) with glasshouse experiments.

P2 - Egg deposition alters volatile emission of *Nicotiana attenuata* in response to herbivore feeding.

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Plants respond to feeding damage by herbivores with various direct and indirect plant defences. In addition, plants may also respond to egg deposition by herbivorous insects, for example with changes of the plant surface such as neoplasm formation or necrosis around the eggs that can weaken egg attachment to the leaf, or with the production of volatiles that attract egg parasitoids. Here we investigate whether plants use egg deposition as a stimulus to prepare itself for future herbivory, as egg deposition by an herbivorous insect often precedes feeding damage by the hatching larvae.

In greenhouse experiments, we examined the effects of egg deposition by *Manduca sexta* on indirect plant defences of *Nicotiana attenuata* in response to subsequent herbivory by its larvae in a full-factorial design. Volatiles were collected one to four days after egg deposition and at the first two days after herbivory of the hatching larvae. While we found no effects of egg deposition on the volatile emission of *N. attenuata*, the volatile blend in response to larval feeding was altered in plants that previously experienced egg deposition. Even though the underlying mechanism and ecological consequences of egg-induced changes in the feeding-induced volatile emission have yet to be elucidated, these first results suggest that insect egg deposition may play an important role as a priming stimulus during the onset of induced defences.

P3 - Direct defence responses in *Solanum dulcamara* after insect egg deposition

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Many plants exhibit inducible defences against herbivores upon herbivore feeding. Because herbivorous insects often oviposit on their host plant, recognition of egg deposition can enable the plant to respond to upcoming attack in an early stage before suffering from feeding damage. Formation of necrotic tissue, neoplasm or hypersensitive response at the site of egg deposition are described for a few plant species and can lower the persistence of the eggs on the plant, but studies on this are rare. We investigated whether *Solanum dulcamara* responds to oviposition by herbivores with i) defence responses that affect the eggs directly or with ii) resistance-enhancing alterations of the defence response induced by the feeding damage of the hatching larvae. We found that *S. dulcamara* exhibits lesions at the oviposition sites of the generalist herbivore *Spodoptera exigua*. We examined whether these lesions are associated with an accumulation of reactive oxygen species and transcriptional regulation of genes involved in hypersensitive response that many plants deploy after pathogen attack. To determine whether the plant's response to oviposition may function as a direct defence against the eggs, hatching rates of clutches with and without contact to the plant were examined. In full-factorial designed greenhouse experiments, we compared larval performance on egg-free and previously egg-laden pants and measured chemical and molecular defence parameters of egg-laden and egg-free plants before and after larval feeding. Our first results indicate that *S. dulcamara* recognises egg deposition of *S. exigua* and responds with direct defence responses that target both, the eggs and the hatching larvae.

P4 - Molecular indices of woody plants as bioreagent markers of urboindustrial load (for example, the zone of influence Burshtyn TTP, Ukraine).

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Strengthening of urboindustrial load on ecotopes causes activation of plant defence mechanisms, which are based on a number of physiological and biochemical reactions. Therefore, changes in rates of molecular level can be seen as early signs of destabilization of ecosystems. The most valuable indicators are woody plants which are the primary barriers to pollutants and reflect the chronic effects of anthropogenic factors.
Studies were conducted during 2007-2012 in the area of influence of Burshtyn power plant, which is the biggest polluter in the Western Ukraine. Foliar physiological and biochemical parameters of the most common woody plants were evaluated. The parameters of molecular level, methods for determining which correspond to the principle of simplicity bioindication research were analyzed.
The results showed that options of photosynthetic systems, nitrogen sharing and free proline concentration had been characterized by the most informative bioreagent. Their dynamics are closely correlated with the level of contamination, particularly with concentrations of heavy metals in soil and plant biomass. The maximum change of the analyzed indicators are observed outside the rollover flare (at the distance of 7-8 km to the northwest from the plant) and the industrial area.
In the leaves of the investigated species the reduction in the amount of plastid pigments mainly due to decrease in the concentration of chlorophyll *a* is observed. This is the most expressed in *Populus pyramidalis* Roz. and *Tilia cordata* Mill, and the least - in *Acer negundo* L. Change in carotenoids has marked species-specific character: a reduction in *Salix caprea* L. and growth for *P. pyramidalis* and *T. cordata.* For *A.negundo*, *Betula pendula* increase in carotenoid content occurs with moderate pollution and decrease at high one. Increase of the content of free proline occurs in this raw: *P. pyramidalis* > *T. cordata* > *B. pendula*> *A. negundo*> *S. caprea*. The growth of protein and non-protein nitrogen is found in *S. caprea* and *A. negundo*; in other species – increasing of the total nitrogen content by increasing its non-protein form.
Thus, the maximum bioreagent prospects at the molecular level mark *P. pyramidalis* and *T. cordata*, and resistance - *A. negundo*, *S. caprea*.

P5 - Plant responses in precipitation manipulation experiments are modified by outside weather conditions

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An increase in precipitation variability including extreme drought is predicted to impact major ecosystem processes. Field experiments for better understanding of plant responses under different precipitation patterns are therefore becoming central in climate impact research. The present study reveals the effect of altered temporal precipitation variability on plant responses by using a rain out shelter technique. Besides, it also quantifies the effects of outside weather conditions on the effectiveness of rain out shelters. Here, contrasting outside weather conditions were evaluated by different temporal cohorts of standardized phytometers, which were set under four precipitation manipulation treatments- low precipitation variability (lowVar), medium precipitation variability (medVar), high precipitation variability with extreme drought (highVar) and roof artifact control (roofArt) in an established field experiment (EVENT 2). Standardized phytometers (potted individuals of *Plantago lanceolata*: same in size, age, pot size, substrate and soil moisture for each experimental run) were exposed in the field experiment for 7 days with replicates during opposing outside weather conditions. Microclimatic conditions inside and outside the rainout shelters were quantified, yet, here we focus on the plant responses. Precipitation variability treatments had significant effects on plant physiology. Higher water stress, lower fluorescence yield and stomatal conductance were observed under highVar compared to lowVar, medVar and roofArt. Furthermore, the phytometers inside the rain out shelters showed significantly higher water stress, lower fluorescence yield, and lower stomatal conductance during warm and dry compared to cool and wet outside weather conditions. We conclude that increased temporal precipitation variability significantly increases physiological stress. The level of stress, however, is strongly modified by outside ambient weather conditions in precipitation manipulations experiments. Our findings will help in improving interpretation of the results obtained in numerous precipitation manipulation experiments.

Session 18 - Foraging Ecology: Foraging accross spatial and temporal scales

Chairs: Jana Eccard, Thomas Hoffmeister

O1 - Species coexistence through foraging behavior

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We present a model for competing central place foragers based on foraging theory. The model predicts how species might coexist depending on how they differently trade off foraging efficiency and travel efficiency. An individual will select its foraging habitat to maximize its fitness, which is determined by the value of patches available to an individual. Patch value can be thought of as a tradeoff between patch quality and foraging distance. A patch of higher quality and close to the nest will have a higher value than a patch of the same quality further away. With this modeling framework we can think of patches in a quality-distance state-space. The model predicts that for any patch quality there is a maximum distance that should be allowed, and this maximum is described by a zero-fitness isocline in the quality-distance state-space. Different species, making different trade-offs between quality and distance, will have different such isoclines. We thus propose that two species with different life-histories can coexist in the same habitat if their fitness isoclines cross such that each species has part of the state-space free from competition from the other species. Hence, the model predicts how resources in an explicit space will be partitioned among species, and how different landscape characteristics can allow different species to inhabit them, alone or with competition from other species.

O2 - What makes a forager leave a resource patch? confronting models with reality

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Imagine an animal searching for patchily distributed resources. At what point in time should the forager decide to leave the patch and search for another patch? And what information may it use for its decision? Optimal foraging models like the marginal value theorem suggest for time limited foragers how to optimize time allocation across resource patches. Yet, the model does not provide mechanisms true foragers may employ. Several proximate patch leaving rules have been proposed, mainly taking into account the motivation to continue searching on the patch. Events like detecting resources are suggested to drive the motivation, yet the behaviours that keep the foragers in the patch or drive them off the patch remain elusive. We developed individual based optimization

models that optimize movement patterns for foragers searching for patchily distributed resources, such that they optimize patch residence times. The tendency to remain on the patch is driven by changes along a gradient from exploitative to explorative movement patterns that are a function of search time, resource encounters and resource distribution. We confront these models with data from parasitoids foraging for hosts that are either dispersed or aggregated across patches and test whether changes in movement patterns predicted by theory are found in live animals.

O3 – The impact of a generalist predator on host-parasitoid interactions on mango

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Communities are often structured by the interactions among species sharing the same habitat. Trophic interactions are particular important, since predator-prey interactions may determine and affect individual behavior and in turn population dynamics and distribution within a community. Moreover, a species can affect its prey not only by direct consumption. Potential prey might adopt evasive strategies in order to avoid predation risks. These changes can be costly and may have a critical impact on the population demography. We studied the interactions between a generalist insect predator, the African weaver ant *Oecophylla longinoda* (Latreille), two species of fruit flies that are primary pests of mango fruits, *Ceratitis cosyra* (Walker) and *Bactrocera invadens* Drew, Tsuruta & White, and their two exotic parasitoids, *Diachasmimorpha longicaudata* (Ashmead) and *Fopius arisanus* (Sonan), that attack larvae and eggs of the flies, respectively. In particular, we investigated (1) if weaver ants interfere with fly or parasitoid fruit foraging behaviour and (2) if and to what degree they impact oviposition behaviour in both the hosts and their parasitoids. Moreover, we explored if flies can reduce their predation risk by adopting opportunistic oviposition strategies.

O4 - Reconciling optimal foraging requirements? Foraging leaf-cutting ants learn to avoid plants that emit herbivore-induced volatiles.

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Leaf-cutting ants (LCAs) are dominant herbivores of the Neotropics as well as economically important pest organisms. Even though their foraging ecology and patterns/mechanisms of food plant selection have received considerable research attention, some of their foraging decisions

remain mystifying since they seem incompatible with the optimal foraging theory. One such behaviour is the premature abandonment of plants that still seem to be a valuable resource.

Harvesting LCAs induce the production of defensive volatile organic compounds (VOC) in their food plants. The ants also have shown the ability to learn to reject food plants that were treated with an artificial fungicide and are therefore no longer suitable as substrate for their symbiotic fungus. Here, we hypothesized that the same learning mechanism occurs in a natural scenario for plants with induced plant defences.

We combined GC-MS analysis of volatile plant emissions with dual-choice bioassays with naïve and experienced LCA colonies. Ants were given the choice between untreated control plants and plants treated with the phytohormone jasmonic acid (JA) to mimic herbivore attack.

Chemical analysis revealed the emission of a characteristic set of herbivore-induced VOC from JA-induced plants. Dual choice experiments indicated that naïve colonies showed indifferent foraging behaviour towards treatment and control plants, while experienced workers avoided JA-induced plants.

Our finding that LCA foragers learn to avoid VOC-emitting plants, which are likely harmful to their symbiotic fungus due to fungicidal components, represents first evidence for avoidance learning by an insect herbivore towards plants emitting defensive volatiles. Furthermore, our results provide a plausible explanation for hitherto unexplained foraging decisions of LCAs in the field and have the potential to reconcile some often-assumed conflicts with optimal foraging theory.

O5 - The role of the neuromodulator octopamine in foraging behavior in parasitoids

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Animals adapt their searching behavior dynamically according to a variety of ecological and physiological circumstances. For instance, in the face of danger a foraging parasitoid balances its decision in respect to its expected future gain rate on a given patch. If they receive a danger cue relatively early after arrival on a patch of a given quality, the wasps tend to ignore the cue and stay, while the same cue leads to immediate patch abundance if the patch is already broadly exploited. While the ultimate causes for this dynamic switch in response are thoroughly discussed the proximate ways of dynamic decision making especially in parasitoids have faced relatively little attention. We found that the neuromodulator octopamine inhibits the response switch and leads to a constant and relatively high leaving probability while dopamine seems to have no effect. However parasitoids fed with octopamine in a simple patch residence time set up without any additional trade-offs stay longer compared to untreated wasps. Therefore we conclude that octopamine rather changes attention in general than the assessment of specific stimuli and may be a key component for patch time allocation in insects.

O6 - Aphid-predator interactions: Costs and benefits of alarm communication in aphids

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Aphids are constantly under attack by a variety of predators and parasitoids. Upon attack, most aphids release droplets from their cornicles that may contain aphid alarm pheromone that induces escape behaviour in other aphid colony members such as dropping off the host plant. In the pea aphid, *Acyrthosiphon pisum*, the only component of this alarm pheromone is the sesquiterpene (E)-β-farnesene (EBF). While EBF has been described in the early 1970s, the dynamics of alarm pheromone signalling in an aphid colony attacked by a predator are not known, due to the difficulties in obtaining real-time measurements of EBF emission. We used a hand-held gas chromatograph (zNose™) capable of repeated quantitative sampling of alarm pheromone to ask the following questions: 1) Are there daily rhythms of EBF emission in the absence and presence of predators? 2) Does aphid alarm pheromone signalling depend on the species of predator attacking? 3) Can emission patterns be linked to behavioural reactions in the aphid colony?

We present data to show that there is no EBF emission by aphids in the absence of predators. Different predators, in our case ladybird and lacewing larvae, cause different daily emission patterns of alarm pheromone depending on the time of activity and mode of predation. Ladybirds generally elicited smaller EBF emission peaks and consumed aphids more quickly, resulting in lower total EBF emission compared to lacewing attacks. Interestingly, not all predation events result in EBF emission even though all aphids contained the alarm pheromone. Escape response by conspecifics differed depending on what predator attacked the colony. Comparing aphid behaviour and real time EBF emission under predation additionally suggests that aphid escape responses are probably initiated when the EBF amount in the headspace shows a sudden increase and stops due to EBF habituation rather than EBF depletion. Overall, our results demonstrate, for the first time, the dynamic nature of chemical communication in animal predator-prey systems.

O7 - Do secondary forests serve as suitable prey foraging habitats for saddleback tamarins (*Saguinus nigrifrons*)?

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Increasing human activity in tropical forest ecosystems raises the question whether the associated secondary forests and their inherent ecosystem processes match the ecological importance of primary forests. Small New World primates of the family Callitrichidae are capable of persisting in secondary forests and are even supposed to benefit from elevated prey abundance in such forests. However, the question of how tamarins forage for prey in secondary forest compared to primary forest has not been examined.

In this study, we compare prey foraging and capture success of two groups of saddleback tamarins (*Saguinus nigrifrons*) in north-eastern Peru, one ranging in primary forest, the other with access to a 10-year old anthropogenic secondary forest. We used scan and focal animal sampling to collect data on the activity, diet composition, prey foraging, and habitat utilization.

There was a trend for higher prey search activity in secondary forest, but prey feeding, prey capture success and prey size was lower compared to primary forest. Tamarins also avoided the forest floor and searched on a lower variety of substrates in secondary forest. As a consequence, tamarins did not capture flushed prey in secondary forest, which accounts for a substantial part of the total prey biomass in primary forest. Finally, tamarins only used secondary forest seasonally and diurnally at times of fruit scarcity and high energy needs.

Our results suggest that young secondary forests meet just a minor part of feeding ecological demands of *S. nigrifrons*, since prey search activity seemed rather opportunistic, presumably influenced by altered predation patterns and vegetation structure.

O8 - Foraging in Risk-uniform Landscapes

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Behaviour is shaped by evolution as to maximise fitness by balancing gains and risks. Models on decision making in biology, psychology or economy have investigated choices among options which differ in gain and/or risk. Meanwhile, there are decision contexts with uniform risk distributions where options are not differing in risk while the overall risk level may be high. Adequate predictions for the emerging investment patterns in risk uniformity are missing. We use foraging behaviour as a model for decision making. While foraging, animals often titrate food and safety from predation and prefer safer foraging options over riskier ones. Risk uniformity can occur when habitat structures are

uniform, when predators are omnipresent, when predators are ideal-free distributed in relation to prey availability. Further, continuous illumination as in cities under light pollution create risk-uniform habitats for nocturnal animals. If the uniform risk is low, local decisions on the marginal value of an option lead to an equal distribution of foraging effort. If the uniform risk is high, foraging is concentrated on few options, due to a landscape-wide reduction of the value of missed opportunity costs of activities other than foraging. We provide experimental support for these predictions using foraging small mammals in artificial, risk uniform landscapes. The observed trade off between gain and risk, demonstrated here for food reduction and safety increase, may possibly apply also to other contexts of economic decision making.

O09 - Foraging of small mammals with predictable and unpredictable resources under different predation risk levels

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Foraging is an elementary behaviour. Especially prey species should not only maximize their energetic benefit, but also minimize the predation risk by deciding e.g. on where to search for food and when to leave a food source. In different risk scenarios optimal foraging behaviour may further depend on the resource distribution and on its predictability. In our study bank voles (*Myodes glareolus*) had the opportunity to exploit limited resources in artificial habitats where the location of the profitable food patch was either predictable (always in the same location) or unpredictable (changing locations). Additionally, we manipulated the perceived risk by offering covered (low risk) or open (high risk) food patches.

Under predictable conditions females visited the profitable food patch significantly more often than expected by random. Males however showed no learning behaviour under this condition. Furthermore, both sexes spent more time in the first visited food patch under predictable conditions. Thereby, females stayed longer in the first patch under high risk, while males did so under low risk. This indicates that the animals are able to detect differences in the risk level but react differently depending on their sex. Similarly, at low risk male voles were more active than females. Males were able to detect changes fast and convert an unpredictable environment into a predictable one by initially locating food patches. Females in contrast were able to remember the profitable patches better, especially under predictable circumstances. They mainly concentrated on the food intake and stayed longer in the first visited patch than in their nest.

The obtained results suggest that sexes follow different interests during foraging. While males are concerned with activities other than foraging, possibly territory defence and the search for mating partners, for females the key factor is the gain of energy. Therefore, males and females pursue sex-specific foraging strategies.

O10 - Variation of tree species diversity on parasitation rate and bottom-up effects on herbivores: a spatial approach on a landscape scale

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Forest ecosystems are slow growing habitats and thus in the past cultivated monocultures still dominate the north-eastern lowland. Since the increased spread and intensity of needle and leaf feeding insect outbreaks is among the most severe impacts of climate warming predicted, the conversion of monocultures to mixed forests has already been implemented for two and a half decades.

However, the effect of general risk reduction through plant and structural diversification has so far been tested on a small spatial scale. In the attempt to use results from small-scale studies to make large-scale predictions, it might be critical that we take into account the greater spatial heterogeneity encountered at larger spatial scales.

To understand the mechanism in caterpillar density determined by stand complexity and plant diversity, we analysed the relation between specialist herbivore larvae and tree species mixture from the stand to the landscape scale. We applied a simple approach, considering circular sections of forests surrounding long-time monitoring sites for three decades using GIS. This reference area ranged from stand (1ha) to 1 km diameter and counted for almost 2000 comparisons of monitored stands per year. Accordingly, herbivores have been shown to experience differential risk of mortality from parasitoids on different stand structures and tree diversity. Therefore, the results are based on population development of caterpillar, showing a cyclic outbreak pattern, the parasitism rate and the diversity of insect parasitoids.

P1 - Pheromones for sustainable control of lepidopterous pests in olive farms in Egypt

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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). The study shows that trapping location and fruit bearing year are characteristics that strongly affect the timing of the control measures. 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. Yield from trees in mass-trapping fields was significantly increased in comparison to control trees. The combination of light and sex pheromone was optimally attractive to ZP moths. The study strongly recommends the use of mass-trapping method instead of pesticides against the ZP moths, not only to control them but also to mass-trap and monitor other lepidopterous pests of olive trees.

P2 - Sex-specific strategies - Do missed opportunity costs cause differences in male and female foraging strategies?

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The risk of predation can have major effects on the life history of prey animals. Thus, evolutionary responses to risk are strong and include habitat selection and temporal variation of activity. Special attention is often given to indispensible tasks; here the trade-off between safety and predation is displayed strongest. But, allocation of time and effort to other activities than foraging such as mate search or territory defense is a crucial task as well; it accounts for the inclusive fitness of an individual on the one hand, but is risky on the other hand. Based on the different interests in alternative activities of males and females of promiscuous species, their foraging behaviour should be different. It should be affected by the different assessment of costs and benefits of alternative opportunities. To analyze differences of male and female activity and foraging strategies, we tested both sexes of the common vole (*Microtus arvalis*) simultaneously in adjoining arenas under different levels of risk of avian predation.

Following a disturbance, males become active earlier. They allocate more time to roaming in the arena, especially when travelling is dangerous. In any treatment, males spend short bouts at the foraging stations (14.3 ± 16.3 min.). Females on the other hand allocate more time to feeding behavior in save situations (23.1 ± 24.8 min) compared to risky treatments (12.3 ± 12.5 min). Nevertheless, the total intake remains the same in both sexes.

Thus, valuable opportunities can evoke risky foraging strategies and risky activity patterns in males. Phases of high activity might be followed by excess mortality due to these conspicuous behaviors. Thus high costs of missed opportunities can contribute to biased operational sex ratios in natural populations by putting the more active sex at higher predation risks. In our study system, excess male mortality can therefore be a result of sexual selection for traits that enhance reproductive success.

Session 19 - Links between the above- and the belowground compartment: functional consequences and impacts of global change

Chairs: Susanne Wurst, Martin Schädler

O1 - Plant diversity effects on soil food webs are stronger than those of elevated CO_2 and N deposition in a long-term grassland experiment

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Recent meta-analyses suggest biodiversity loss affects the functioning of ecosystems to a similar extent as other global environmental change agents. However, the abundance and functioning of soil organisms have been hypothesized to be much less responsive to such changes, particularly in plant diversity, than aboveground variables, though tests of this hypothesis are extremely rare. We examined the responses of soil food webs (soil microorganisms, nematodes, microarthropods) to 13-year manipulation of multiple environmental factors that are changing at global scales – specifically plant species richness, atmospheric CO2 and N deposition – in a grassland experiment in Minnesota, USA. Plant diversity was a strong driver of the structure and functioning of soil food webs, through several bottom-up (resource control) effects, while CO2 and N only had modest effects. We found few interactions between plant diversity and CO2 and N, likely because of weak interactive effects of those factors on resource availability (e.g., root biomass). Plant diversity effects likely were large because high plant diversity promoted the accumulation of soil organic matter in the site's sandy, organic matter-poor soils. Plant diversity effects were not explained by the presence of certain plant functional groups. Our results underline the prime importance of plant diversity loss cascading to soil food webs (density and diversity of soil organisms) and functions. Since the present results suggest prevailing plant diversity effects and few interactions with other global change drivers, protecting plant diversity may be of high priority to maintain the biodiversity and functioning of soils in a changing world.

O2 - Tracing recently-fixed carbon in beech trees from the leaves to the roots in response to environmental stress

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Carbon is exchanged between biosphere and atmosphere by photosynthesis and soil respiration. Both processes are connected via transport of carbohydrates from the leaves to the roots. To understand the complex responses of carbon allocation to changed environmental conditions, it is useful to investigate causal patterns under controlled conditions.

The purpose of this study is to quantify the allocation pattern of recently-fixed carbon in young beech saplings in response to increased temperature and drought by tracing carbon allocation into different plant tissues and components with a pulse-labeling experiment using 99% $^{13}CO_2$. The fate of the ^{13}C label was tracked by six harvest points within nine days after labeling.

Drought plants showed effects on the root/shoot ratio in favor of the root biomass. Sink strength approximated by soil CO_2 efflux increased under warmer temperature and moist soil conditions. The leaf and root bulk $\delta^{13}C$ value of unlabeled trees harvested before labeling even showed a clear influence of temperature with lower $\delta^{13}C$ values for the warm treatments.

All plants show a fast transport of ^{13}C label from leaves to roots, latter showing a ^{13}C enrichment already one day after labeling. The fast transport is supported by increased $\delta^{13}C$ values of twig and stem phloem already three hours after labeling. While twig phloem $\delta^{13}C$ values peaked on the day of labeling for all treatments, drought and increased temperature delayed the $\delta^{13}C$ peak in stem phloem close to the ground. This means that the transport was slowed down under drought and increased temperature. The temperature effect on transport velocity of carbohydrates in the phloem is further confirmed by a delayed peak in $\delta^{13}C$ values of soluble sugars in roots.

Tracing the ^{13}C label from the above- to the belowground compartments helps to get an insight into the effect of changed environmental conditions on transport velocity and distribution of recently fixed carbon.

O3 - Influence of macrofauna-mesofauna interactions on ecosystem processes

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In the laboratory we investigated if effects of soil meso- and macrofauna on ecosystem processes and functioning depend on the ecological group of the organisms. Individuals of two different species of springtails (*Protaphorura armata* - endogeic, *Heteromurus nitidus* -hemiedaphic) and earthworms (*Aporrectodea caliginosa* - endogeic, *Lumbricus terrestris* - anecic) belonging to different ecological groups were introduced in varying combinations into mesocosms each containing one two year old beech seedling, defaunated soil and ^{15}N labeled beech litter. Treatments were replicated four times. After three months the mesocosms were destructively sampled, and soil animals were extracted, counted and identified. Trees were subdivided into roots, stem and leaves and weighed to quantify changes in biomass of different plant compartments. Soil animals, tree compartments, soil and litter were analyzed for total N and ^{15}N to quantify nitrogen dynamics during the experiment.

First data on the effects of the identity, functional group affiliation and diversity of soil animals on decomposition, tree growth and N cycling will be presented.

O4 - Effects of plant and soil decomposer diversity on ecosystem functions

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Biodiversity is a crucial component for ecosystem functioning. Therefore, many efforts have been made to investigate the relationship between biodiversity and ecosystem functioning, but were mostly limited to the diversity within one trophic level. Recent studies found loss of plant diversity leading to extinction cascades in terrestrial belowground food webs, thus reducing diversity of soil decomposer fauna. As decomposers are essential for nutrient mineralization and element cycling, the present study aimed at investigating the impacts of both plant species and decomposer species diversity on ecosystem functions, such as primary productivity and nitrogen fluxes. We set up a climate chamber microcosm experiment and crossed a plant diversity gradient (1-6 plant species, native to the Central European Arrhenatherum grasslands) with a soil decomposer diversity gradient (1-6 soil decomposer species, Collembola and earthworm species native to Central Europe), with three diversity levels each. The plant and decomposer species had been selected based on their functional dissimilarity to test for niche complementarity effects. We found significant diversity effects of both trophic groups investigated. In particular, belowground decomposer species richness promoted primary productivity (above- and belowground), and plant species richness enhanced community root biomass. Furthermore, the resource use efficiency of soil microorganisms were significantly affected by decomposer species richness. Our results suggest that both decomposer diversity and plant diversity are vital drivers of ecosystem functioning in terrestrial ecosystems.

O5 - Plant-mediated indirect interactions between above and belowground feeding herbivores depend on nitrate fertilisation

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Feeding by a herbivore can change the metabolite composition of the host plant in a fine-tuned way. If the metabolite composition is also modified in systemic tissue, herbivores feeding on different plant parts or compartments may influence each other indirectly, mediated by metabolic changes of the plant. Furthermore, plant responses and indirect interactions between herbivores should be modulated by factors of global change such as increased fertilisation, but research is scarce on this topic. We investigated plant-mediated indirect interactions between aphids feeding aboveground and nematodes feeding belowground on the plant *Arabidopsis thaliana* under two different nitrate fertilisation conditions and measured plant growth traits and metabolic changes due to herbivory. We found that nematodes had only minor effects on aphid performance, whereas influences of aphids on nematodes were more pronounced and depended on nitrate availability of the host plant, with either promoting or suppressing effects. Results are discussed by correlating the data with plant growth characteristics and metabolite profiles of differently treated plants. Our data demonstrate that even slight changes in plant nutrition or metabolism due to global change can have tremendous effects on the outcome of plant-mediated interactions between above- and belowground herbivores.

O6 - Plants in a heterogeneous world: effects of abiotic factors on above- and belowground defence profiles

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Abiotic factors influence the development, defence system and fitness of plant individuals to different degrees, whereby even within a species the responses can vary. Many essential oil-accumulating plant species show a high intraspecific diversity in the terpenoid composition of their leaves. To what extent abiotic conditions influence the concentration of terpenoids is inconsistent across herbs and trees and has been rarely tested for species with intraspecifically distinct secondary metabolite profiles, known as chemotypes, in different plant parts. *Tanacetum vulgare* L. is a prominent example showing various chemotypes that differ in composition of mono- and sesquiterpenoids in their shoot tissues, but little is known whether the root terpenoid profiles mirror the shoot chemotype grouping. We investigated the effects of different fertilisation on the terpenoid concentration of above- and belowground organs as well as morphological traits and plant growth of three chemotypes of *T. vulgare*, carvyl acetate, β-thujone, and camphor. The chemical analyses revealed distinct terpenoid profiles in above- vs. belowground organs. Monoterpenoids dominated the leaf profiles whereas mainly sesquiterpenoids were found in the roots with only week matches of shoot chemotype grouping. With increasing fertilisation a decreasing terpenoid concentration in the leaves was observed, but root terpenoid concentrations were not affected by changes in nutrient supply. The number of trichomes and glands correlated with the terpenoid concentration but did not differ between fertiliser treatments. Furthermore, chemotype specific responses were found for C/N ratio and plant height. Our results indicate different selection pressures on below- and aboveground plant organs.

O7 - Impact of water potential on germination of flood meadow species

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Floodplain meadows are diverse plant communities, threatened by land use changes and habitat loss, and protected by the FFH Directive. These ecosystems are characterized by high water level fluctuations with flooded conditions in winter/spring and dry periods during summer. Climate change scenarios indicate an increasing risk for summer drought due to less summer precipitation along the northern Upper Rhine and the Middle Elbe River, Germany. While adult plants often show no immediate response to changes in water availability, the early life stages might be more sensitive. Germination, taking place at the interface of above- and belowground compartments, is especially depending on soil moisture. How will reduced soil water potentials in the floodplains along the Rhine and Elbe River affect the germination of meadow species indicating wet and dry habitats? Our hypotheses were: 1) Reduced water potential will lower the germination of all plant species. At low water potentials seed germination of plants occurring in wet habitats will decrease more than those indicating dry habitats. 2) Germination of seeds from the River Elbe, where annual precipitation is generally lower, will be more successful at reduced water potentials than seeds from the Rhine River.

We exposed seeds of 20 rare and common floodplain meadow species to a water potential gradient ranging from no water limitation to the permanent wilting point. Moisture requirements of the study species were classified according to the Ellenberg indicator value for moisture. We used the osmotic agent mannitol to establish standardized water potentials. Soil water potentials of 0, -0.25, -0.5, -1.0, and -1.5 MPa were tested at two temperature regimes (15/5°C and 20/10°C).Our response variables were germination percentage, germination time and the synchrony of germination.

Germination percentage and synchrony of germination decreased and germination time increased at reduced water potentials. Results indicate that the species’ reaction depends on the habitat (wet vs. dry). Surprisingly, germination of the plant species indicating dry habitats decreased stronger with lower water potentials than that of species indicating wet habitats. Seeds from the river Elbe did not differ in the measured germination parameters to those originating from the Rhine River.

O8 - Testing the trait effect-response framework in a tropical ecosystem: The Kilimanjaro model

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Current research in plant functional traits either addresses how consumers and biogeochemistry depend on specific functional traits, or focuses on responses of plant functional traits to environmental drivers. However, response and effect traits sometimes overlap, i.e. traits can both explain plant responses to environmental conditions and effects on the ecosystem. Therefore, a combined analysis of trait responses to the environment and the subsequent effects on ecosystem properties has been proposed (“response-effect framework”), but rarely adopted in natural landscapes.

Here, we apply the response-effect framework to the ecosystems of Mt Kilimanjaro, Tanzania, based on an extensive multidisciplinary sampling program on 60 plots representing the major natural and anthropogenic ecosystems. We assumed that response and effect traits are well correlated on the resource gradient but less so on the disturbance gradient: The higher the disturbance, the more relevant are regenerative response traits which have no effect on ecosystem properties.

We used structural equation modeling to identify the traits that best explain environmental factors as well as ecosystem functioning in a simultaneous analysis. Regarding trait-trait relationships, specific leaf area was strongly negatively related to leaf dry matter content, stem dry matter content and stem specific density. This is in line with the leaf economics spectrum that runs from acquisitive plants with rapid turnover of resources to conservative plants with slow turnover. These leaf and stem traits showed parallel responses to human disturbance and to variations in temperature, ranging from hot conditions in savannas to cold conditions in the subalpine regions. Canopy height and leaf area however followed the precipitation gradient, which was uncorrelated to the temperature and disturbance gradient. Ecosystem properties were partly contingent on direct environmental effects and on indirect effects mediated by plant traits.

We conclude that although the generality of ecosystem interdependencies seems to be stable across the latitudinal gradient, specific qualities of tropical ecosystems as a year-round relatively constant climate in the rainforest zones and strongest seasonality in dry regions have a strong impact on certain linkages.

P1 - The impacts of below-ground mutualists on plant defenses of *Brassica rapa* against above-ground herbivores

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Interactions between soil microorganisms and plants can impact above-ground plant herbivore dynamics. Association between plants and beneficial soil microorganisms, such as plant growth promoting rhizobacteria (PGPR) and arbuscular mycorrhizal fungi (AMF) can improve plant growth and potentially alter plant defenses against above-ground antagonists. Soil fauna, such as earthworms, have been shown to stimulate the soil microbial community, perhaps amplifying their effect on plant defense and above-ground herbivores. We aim to investigate the effects of major plant mutualists, AMF (*Glomus* spp.), PGPR (*Pseudomonas fluorescens*), and earthworms (*Aporrectodea caliginosa)* on *Brassica rapa* (Teltower Rübchen) growth, glucosinolate biosynthesis, and above-ground interaction with leaf-chewing herbivores. A greenhouse experiment in a completely randomized block design will be established to test our hypotheses. The results will be presented and discussed.

P2 - Absence of soil frost affects plant-soil interactions in temperate grasslands

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Background and aims

Intermittently frozen ground in winter is expected to disappear over large areas in the temperate zone due to ongoing climate warming. The lack of soil frost influences plant soil interactions and needs to be studied in more detail.

Methods

Winter soil frost was avoided by belowground heating wires in a field experiment over two subsequent winters in temperate grassland. Soil respiration, soil nitrogen availability and plant performance (aboveground biomass, root length at two depth levels, greenness, nutrient content) were compared between "no-frost" and reference plots which underwent repeated freeze-thaw cycles in both winters.

Results

Soil respiration increased in the "no-frost" treatment during the warming phase (+291 %). N-availability in the upper 10 cm of the soil profile was not affected, possibly due to increased plant N accumulation during winter (+163%), increased plant N concentration (+18%) and increased biomass production (+31.5%) in the growing season. Translocation of roots into deeper soil layers without changes in total root length in response to the "no-frost" treatment, however, may be a sign of nutrient leaching.

Conclusions

The cumulative effect on carbon cycling due to warmer soils therefore depends on the balance between increased winter carbon loss due to higher soil biotic activity and enhanced plant productivity with higher nutrient accumulation in the growing season.

Reference

Schuerings et al. (2013) Absence of soil frost affects plant-soil interactions in temperate grasslands. Plant and Soil. DOI: 10.1007/s11104-013-1724-y.

P3 – Mosses, vascular plants & soil interactions. An example from Icelandic subarctic tundra

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Mosses are an important component of many ecosystems of the arctic and subarctic tundra and these fragile ecosystems are expected to be affected by changing climate. To improve predictions of ecosystem responses to climate change it is important to improve understanding of the role of mosses in ecosystem functioning and their interaction with vascular plants. In our study of moss-dominated highland ecosystems in subarctic Iceland we ask: How does the moss cover affect selected soil properties and the survival, growth and reproduction of vascular plants?

Relationships between variable moss depth and selected soil properties (soil temperature, moisture, respiration, pH, microbial biomass and available NO_3^--N or NH_4^+-N) were examined in 30 plots (30x30 cm) in relatively dry dwarf birch heath community (Auðkúluheiði, 65°N, 480 m elevation).

The dominating moss species is *Racomitrium lanuginosum* with average cover 90%. To study the interaction between moss cover and vascular plants, a moss removal experiment was set up in June 2011 with four target species: *Betula nana*, *Empetrum nigrum*, *Silene acaulis* and *Carex rupestris* present in each plot (50x50 cm, total of 27). Three treatments were applied, 1) all moss removed, 2) moss cover thinned 50% and 3) no moss removed. Target species responses were measured in August 2012 and 2013.

With increasing moss depth the soil temperature decreased and daily temperature fluctuations were reduced. Soil moisture increased with moss depth and soil microbial biomass increased with increased moisture. The target species responses differed depending on treatments.

These results show that the *Racomitrium lanuginosum* cover plays an important and complex role in Icelandic subarctic tundra. It acts as an insulator for soil temperature and retains moisture, which is a key factor in ecosystem processes in harsh environment of the Icelandic highlands.

KEYWORDS: MOSS DEPTH, MOSS-VASCULAR PLANTS INTERACTIONS, SOIL MICROBIAL BIOMASS, SOIL TEMPERATURE, SUBARCTIC TUNDRA.

Session 20 - Spatial patterns and ecological processes

Chairs: Kerstin Wiegand, Katrin M. Meyer

O1 - Interaction scales revealed with spatial statistics

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Ecological processes and interactions operate on a range of different spatial scales. The quickly evolving field of spatial statistics offers a diverse set of methods to identify critical scales of interactions between species and their environment. The acquired information can improve our understanding of ecosystems and fuel model parametrization. In this talk we show how selected spatial methods can be applied to identify interaction scales in different ecological settings. Point-pattern analysis tools such as Ripley's K or the pair-correlation function examine interactions between spatial points within a pattern or between patterns. The points may represent such diverse ecological entities as individuals, colonies, nests or abiotic features of the landscape. Adaptations of these methods can be applied to analyze the spatial scales of interactions of linear or areal objects, such as roads, hyphae, waste dumps or water bodies. We will exemplify these applications with data from a microbial ecosystem. In summary, these and other scale-explicit methods from spatial statistics offer a great variety of powerful tools for ecologists to study biological interactions.

O2 - Resolving the independence null model problem in spatial ecology using pattern reconstruction

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Recent debates around niche versus neutral theories have called for a rigorous determination of the relative contribution of habitat specialization and species interaction to community assembly and biodiversity. The central issue in this testing is to find a suitable null model which represents the case of no spatial association between species distributions and habitat variables and that accounts for the possible spatial autocorrelation of the individuals of the species. In this study we applied a novel null model based on pattern reconstruction which produces stochastic replicate patterns that show the same stochastic properties as the observed species patterns. We used this 'close-to-nature' null model as benchmark and compared three other tests of spatial independence that are based on complete spatial randomness (CSR), the Thomas cluster process or torus translations against the outcome of pattern reconstruction. The tests were conducted for real tree data on newly recruited individuals of 108 species in a tropical forest on Barro Colorado Island (Panamá) and the spatial associations in all possible 108 × 107 pair-wise species combinations were analysed. To investigate mismatches between null models, we additionally tested for independence between null-model results and habitat association of species, clustering of species, and the number of individuals per species. In about 60% of all 11,556 species combinations all four tests of spatial independence produced the same results. However, in the rest of the cases there was a marked mismatch in the outcome of the different null model tests. In 32% CSR indicated significant deviation from species independence when pattern reconstruction showed no deviation. This was especially the case when the first, but more importantly, the second species of a pair was highly abundant, strongly clustered, and significantly associated with a topographic habitat variable. In 19% mismatches with pattern reconstruction occurred for the Thomas process but only in 4% for the torus translation test. Overall, our study shows that conventional tests of spatial independence bear the danger of overestimating significant species associations. For future studies we recommend application of pattern reconstruction to adequately test for species independence in plant communities.

O3 - Can a neutral model explain detailed spatial community patterns of large trees in tropical forests?

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The neutral theory of biodiversity and biogeography provides a hotly debated model of the dynamics in species-rich communities. However, while neutral models provided a good fit to species abundance distributions and species-area relationships, it is not clear if they are able to simultaneously approximate several detailed spatial patterns, which are provided by fully mapped forest dynamics plots.

In this study, we address the question, if a neutral model is able to explain spatial patterns observed for large trees in the forest dynamics plot in Barro Colorado Island (BCI), Panama. For this purpose, we develop a new spatially-explicit neutral model, which describes tree competition and recruitment based on the zone-of-influence (ZOI) approach. We use approximate Bayesian computation (ABC) to estimate eight parameters of the neutral model. For the ABC approach we use four non-spatial patterns (species richness, Shannon-diversity, death/recruitment events, species abundance distribution) and three spatial patterns, which reflect the aggregation and segregation of tree individuals and tree species (pair correlation function, proportion of conspecific neighbours and the individual species-area relationship).

We found that the neutral model is indeed able to simultaneously approximate the non-spatial and spatial patterns of large trees in the BCI forest plot. However, the neutral model overestimated average species' aggregation and underestimates the variability of species' aggregation.

We conclude that several aspects of spatial patterns of adult trees in tropical forests can arise by purely neutral processes such as dispersal limitation. This leads to the question, how non-neutral processes, which have been found for seedlings and juvenile trees are neutralized at the transition to the community of large adult trees.

We suggest that the combination of extensive spatial data with spatially-explicit models offers a promising approach to answer the question of the relative importance of different process in the assembly and dynamics of species rich communities.

O4 - Linking trait similarity to spatial patterns of tree species co-occurrence in a wet tropical forest

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Community assembly theory predicts that niche differentiation promotes the spatial clustering of functionally dissimilar species, whereas habitat filtering has the converse effect. These predictions are clear, but a lack of spatial point pattern analysis has often muddied the interpretation of previous studies. We tested these predictions over three census periods in the forest dynamics plot at Barro Colorado Island, Panama. We integrated data on the spatial patterns of >1-cm dbh recruits with data on seven soft and hard traits for 64 species. First we adapted the cumulative nearest neighbor distribution $D_{ij}(r)$ and K-functions $K_{ij}(r)$ from bivariate point pattern analysis to develop an index of species pairwise co-occurrence. Then we examined the relationship between trait similarity and the index of co-occurrence for each species pair using standardized major axis (SMA) regression. More than one-half of species pairs were spatially independent, but for pairs that were spatially dependent, the relationships between trait similarity and co-occurrence were mostly negative. These results indicate that competition was more important than habitat filtering in assembling recruit communities at both 5-m and 30-m scales. Competition reinforced the growth-mortality trade-off along a gradient of light availability, as co-occurrence was inversely related to similarity among species in maximum growth rate, shade-tolerance index and wood specific gravity. Competition was strongest after the El Niño event of 1982-83, but continued to structure of recruit communities during 20 years. Habitat filtering mainly acted upon traits related to topographic habitat preferences and dispersal mode. These findings suggest that competition and limiting similarity along resource gradients structure tropical forests more strongly than has previously been appreciated, and emphasize the role of functional traits in plant community assembly.

O5 - Dispersal limitation and environmental factors shape tree community structure across life stages at multiple scales in tropical forests

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Environmental filtering and dispersal limitation are known to influence the compositional structure of tropical forest communities. In this study, we examine the relative contributions of these processes with variation partitioning at different life stages (i.e., recruit, juvenile and reproductive stages and the survivors) and scales. Here, we used the environmental data and spatial component represented by topography and soil nutrients and a principal components of neighbor matrix (PCNM), respectively, within a 50 ha tropical forest plot, and used variation partitioning to decompose community compositional variation into fractions explained by spatial, soil nutrients and topographic variables. Variations accounted by environmental and spatial components in community compositions among life stages increased with the spatial scale of the analysis. At 20m × 20m spatial scale, variations accounted by topography and soil resources were low for recruit community (< 1% and 6%, respectively) and high for juvenile community (11% and 19%, respectively). Soil resources accounted for more variation than topography in community composition in all life stages and scales. All environmental variables together explained 7% and 21% for recruit and juvenile communities, respectively. However, variations explained by spatial component alone for recruit and survivor communities were 14% and 9%, respectively, suggesting an important role for dispersal processes and unmeasured environmental variables at recruitment stage. Interestingly, variations explained by environmental variables showed a decreasing trend in time except in first census for all life stages, suggesting that spatially structured habitat became noisier over the 25 years of the study. Our results suggest that dispersal limitation plays an important role in recruitment stage, while both habitat filtering and dispersal processes structure the communities in later development stages.

O6 - Testing point pattern analysis in a heterogeneous semi-natural forest

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Spatial statistics are used to reveal underlying processes and relevant scales. Point pattern analysis (PPA) is frequently applied in species-rich tropical forests to characterise spatial forest dynamics. However, the ecology of many tropical species is not well understood. Thus, it might go unnoticed if pieces of information are lost. Spatial patterns are especially prone to misinterpretation if scales of environmental heterogeneity are unknown. We revisited the well-known system of a mixed beech forest with these new methods. We use data from a heterogeneous study area in a semi-natural forest in the Hainich National Park, Germany. Over 15,000 trees (28.5 ha) were twice fully mapped (1999 and 2007). The study site has small- and large-scale heterogeneity, e.g. in soil properties. To relate the PPA results to known or assumed species traits, we applied several PPA statistics: uni- and bivariate distance measures, nearest-neighbour statistics and mark-correlation functions. To account for spatial heterogeneity, we included abiotic covariates such as soil depth and wetness. These methods allowed us to disentangle effects of habitat heterogeneity and tree-tree interactions at different scales. First results show that PPA can correctly detect type and strength of interaction at different scales as well as the dependence of these patterns on species identity and tree size. PPA also captures species identity effects, e.g. strong asymmetric competition, and segregation at the between- and the within- species level. However, knowledge of possible confounding factors (e.g. management legacy, herbivory) seem to remain necessary: From PPA only, the detected lack of rejuvenation in species other than beech might have been attributed to competition between trees or to unsuitable habitat alone, whereas we tend to assume that this can also be attributed to former management practice and to a high density of browsers.

O7 - Spatial distribution of the babassu palm and of Leguminosae in secondary regrowth of the eastern periphery of Amazonia

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The ruderal babassu (*Orbignya phalerata* Mart., Arecaceae) palm is of exceptional ecological and socioeconomic importance throughout peripheral Amazonia, especially in frequently-burned degraded lands, and virtually omnipresent throughout pastures, shifting cultivation fields and secondary forest regrowth of the ‘arc of deforestation’. In order to get a better understanding on the ecology of the babassu palm and of its multiple interactions with its surroundings, we investigate the spatial distribution of juvenile and adult babassu palms and in parallel of all legume trees and lianas. We completely mapped both vegetation components in six 0.5 ha secondary regrowth sites with low or high babassu dominance, 3 or 20 years of age, and from two ~600 km distant study regions (São Luis / Teresina) of the eastern periphery of Amazonia. We subsequently conduct point pattern analyses via Ripley´s L and O-ring statistics, taking heterogeneous Poisson process as null model. Results point to (i) an aggregated distribution both of babassu and of legume vegetation as a whole, both of legume trees and lianas, and of most of the common legume species or genera, over all 6 sites, independent of vegetation age, babassu dominance (low vs. high) and study region, maximum clustering distance ranged from 4-10 meters. (ii) Bivariate point pattern analysis indicates positive deviations from simulated randomness between babassu and legume vegetation components in all sites and over most of the common legume tree and liana species and genera, as well as legume trees and lianas as a whole. This suggests that the babassu palm and the legume vegetation components occupy similar ecological niches and compete for similar resources in secondary fallow regrowth in the Amazonian arc of deforestation.

O8 - Influence of tree cover on herbaceous layer productivity, species development and longevity in a Portuguese cork oak woodland

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Facilitation and competition interactions between different vegetation layers may have a huge impact on small-scale vegetation development and trace gas fluxes. Here, we analyzed the effects of trees on microclimate and soil properties (water and nitrogen content) as well as the development of an herbaceous community layer regarding distribution, biomass and net water and carbon fluxes in Portuguese cork oak woodland. Microclimatic conditions, soil nitrate and herbaceous layer gas exchange, biomass development and vegetation distribution were assessed throughout 2011 directly below the canopy of cork oaks and in an adjacent open area.

The presence of oak trees significantly altered microclimate causing a reduction in radiation of 35 mol m^{-2} d^{-1} and a reduction in soil temperature by 5°C from April to October. In contrast to expectations, this did not result in a facilitating effect of tree cover on herbaceous layer productivity, i.e. total biomass production or cover. However, differences in community development between sites could be observed: the herbaceous layer developed similarly during fall and early spring regarding species composition and biomass production, but species composition and functional group dominance started to deviate between sites from mid April. During late spring drought adapted native forbs were dominant in the open area while grasses and nitrogen fixing forbs dominated under the trees. Further, evapotranspiration and net carbon exchange decreased significantly stronger on the tree site compared to the open site during late spring and the die back of herbaceous plants occurred earlier and faster on the tree site. This was most likely caused by interspecific competition for water between trees and herbaceous plants, despite the more favorable microclimate conditions during the onset of summer drought.

Our results show that the sparse tree cover creates a spatially heterogeneous herbaceous vegetation mosaic driven by a sensitive equilibrium between facilitation, i.e. more favorable microclimate conditions under trees, and competition for water and nutrients.

O9 - Responses of ecological traits to climate on large spatial scales

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Ecological traits exhibit lower variability when compared to taxonomy-based analyses and thus help in understanding the response of population and communities to stressors such as climate change. Climate change affects ecosystems and has been shown to influence the trait composition of macroinvertebrate communities. However, the response of traits to climate has rarely been studied over large spatial scales. Since classically spatial pattern, i.e. spatial trend and spatial autocorrelation, is known to be a property of large scale climate variability, the spatial distribution of climate-sensitive ecological traits should follow an associated pattern. In this study, we examined the relationship between selected ecological traits from Freshwater Macroinvertebrates (FM) in German streams and Bioclimatic (BI) variables. We selected six different traits of FM based on *a priori* ecological reasoning and recent investigations on potential responses to climate change. On an average, 20% of the spatial variation in FM traits could be explained by the BIs. Subsequently, the residuals for the traits were checked for spatial autocorrelation and spatial trend to examine the presence of unexplained spatial patterns that are not related to BIs. However, no statistically significant pattern was identified. Thus, the spatial pattern in climate sensitive traits on the scale of Germany is mainly related to bioclimatic variables. Our findings are relevant to predict the response of FM traits to future climate change.

O10 - Process-based estimation of niches and range dynamics from demographic field data and range-wide abundance patterns

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The geographic patterns of species distributions are determined by the interplay of dynamic processes of reproduction, mortality and dispersal in a spatially and temporally heterogeneous environment. Yet widely applied species distribution models (SDMs) take a phenomenological and static approach on species´ ranges and ecological niches.

Here, we propose a process-based approach for the statistical estimation of Dynamic Range Models (DRMs) from biogeographic and demographic data: DRMs integrate Hutchinson´s niche concept with spatial population dynamics in a hierarchical Bayesian state–space model to estimate the environmental response of demographic rates, local population dynamics and dispersal rates conditionally upon each other while accounting for various sources of uncertainty. The approach thereby jointly infers species´ niches and spatio-temporal population dynamics from data and provides probabilistic forecasts of range dynamics under environmental change. Parameters of the model are related to demographic rates that can be measured in the field or in experiments. Within the hierarchical model structure ecological niches can thus be quantified from a combination of measured demographic rates and biogeographic distribution data.

In a case study we investigate the range dynamics of serotinous shrubs (*Proteacea*) in the South African Fynbos. For the quantification of species´ niches in terms of demographic response functions we assembled a dataset that describes how demographic rates (mortality, fecundity, recruitment) vary in more than 2500 populations across the ranges of 25 *Proteacea* species. These field data are combined with information on long-distance seed dispersal and data on range-wide variation in population size from the Protea Atlas database to estimate DRMs and to analyze how interactions between species-specific demographic response functions and spatial population dynamics drive the formation of species´ ranges.

O11 - Cover balance or degree of autocorrelation? It is the same and integratively traces pattern formation during succession

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It is widely acknowledged that increasing complexity is a key attribute of ecosystem genesis. This is particularly true for primary succession on homogeneous substrates. However, a mechanistic understanding of spatial colonisation and pattern formation during primary succession has not been achieved yet. Thus, we studied this topic for 7 years within an experimental catchment (6 ha) established in the post-mining landscape of eastern Germany. Equidistant permanent plots (120 plots à 25m²) allowed for autocorrelation analyses, and thus tracing the spatial development of species cover performance. For each species tested, the “cover balance” first increased due to colonization, while decreasing in the course of succession. Drawing a benefit from these temporal trends, we suggested cover balance levels revealed by autocorrelation analyses to best indicate well-defined phases in primary succession at spatial entities (Zaplata et al. 2013). Hence, with the help of this spatial approach, terrestrial succession can be understood now much better at the most general level of the hierarchy provided by Pickett et al. (1987). In accordance with these authors, at subordinated levels of the causal hierarchy differential species performance might get collectively explained by contributing processes or conditions, such as ecophysiological traits, life history

strategies, competition and allelopathy of the occurring plant species. Further research is needed to understand their relative contributions to the pattern formation.

Pickett STA, Collins SLJ & J Armesto (1987) A hierarchical consideration of causes and mechanisms of succession. Vegetatio 69: 109-114

Zaplata MK, Winter S, Fischer A, Kollmann J & W Ulrich (2013) Species-driven phases and increasing structure in early-successional plant communities. The American Naturalist 181: E17-E27

O12 - Spatial and temporal phylogenetic turnover during subtropical forest succession across ecological and phylogenetic scales

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The study of changes in community phylogenetic structure (e.g. phylogenetic turnover) during succession may provide insights into the processes that generate biodiversity during post-disturbance ecosystem development. Despite the fact that phylogenetic signal in community composition (a) may only be detected at particular taxonomic levels and (b) can vary along abiotic gradients, studies of phylogenetic structure in successional systems have yet to integrate spatial and temporal phylogenetic turnover at different phylogenetic and ecological scales. We used chronosequence data (from BEF China), with plots ranging from 22 to 116 years, representing a subtropical forest succession. Levels of spatial and temporal phylogenetic turnover were assessed. Null models were used (a) to test whether species within sites were significantly more (or less) closely related to each other than to species from different sites and (b) to assess whether phylogenetic structure occurs at particular depths in the phylogeny. The fact that between-stage turnover was lower than random expectation and lower than within stage turnover suggests an absence of phylogenetic shifts over succession. Within-stage phylogenetic turnover was higher than expected by chance, and higher than between stage turnover, indicating that there are filtering processes, independent of the process of succession, that have selected for closely related species. Our finding that phylogenetic clustering was only detected within late successional stages, and was explained by environmental factors, suggests that the relative importance of abiotic filtering increases during the course of succession. Significant phylogenetic turnover mainly occurred deep in the phylogeny and is likely to reflect phylogenetically conserved adaptations to an underlying environmental gradient. Our study highlights the imprint of evolutionary history on temporal changes in community composition during ecosystem development.

O13 - Namib Desert Fairy Circle landscapes: Multiple links between spatial patterns and ecological processes

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Fairy circle ecosystems (FCE) in the Namib Desert form spatial patterns that are related to a number of ecological processes. These are controlled by the individual life history of each FCE, by several environmental gradients, by a complex form of competition for space, water and plant biomass and by a food web that stepwise develops with increasing age of the FCEs.

The presentation will disentangle the various processes and spatial and temporal scales involved in order to establish a framework for an in-depth study of the involved processes and their impact on pattern formation.

O14 - Landscape and local drivers of pollen beetle dynamics and parasitism

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Most ecological processes and interactions depend not only on the local habitat, but also on the spatial context at larger scales. Therefore, it is important to link local ecological processes, such as trophic interactions, and spatial patterns at different scales. An interaction affected by different spatial scales is the trophic cascade represented by oilseed rape plants (OSR, *Brassica napus* L), the pollen beetle (*Brassicogethes aeneus* Fabricius) and its parasitoids.

Previous studies exhibited contrasting results regarding how and at which spatial scale semi-natural habitats (SNH) and OSR affect pollen beetle abundance and parasitism rates.

We use a novel grid-based sampling approach covering ten 1x1 km landscapes (representing a gradient in proportion of OSR) to study the spatio-temporal dynamics of pollen beetle abundance. This approach allows interpolation among sampling points and explicit modeling of spatial autocorrelation at different spatial scales. Pollen beetles were caught using yellow pan traps at early vs. late OSR flowering.

At the landscape scale and at early OSR flowering, pollen beetle abundance declined with increasing amount of OSR. That indicates a landscape scale dilution effect on pollen beetles at early stages of OSR flowering, likely because of the inter-annual increases in OSR area, causing a dilution of the pest population over a larger crop area. At the local scale (individual cells) and at late OSR flowering, there were more pollen beetles when there was a lot of OSR in the landscape. This may be a consequence of lower parasitism rates, since a significant interaction between OSR at local and landscape scale showed that the parasitoid population was increasingly diluted with greater proportions of OSR at local scale.

In conclusion, pest management strategies need to include larges spatial scales and require a comprehensive understanding of the scale-dependent drivers of pest density and biological control.

O15 - How does disturbance by sheep grazing affect the spatial structures of tundra plant communities?

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Plant communities are shaped by abiotic conditions such as temperature, moisture or nutrient supply, factors that are strongly depending on topography. Topography and factors associated to it shape plant community patterns at several spatial scales. Studies from the low arctic tundra indicate that large herbivores (ungulates) may modify these spatial patterns, possibly leading to decreased community differentiation and therefore decreased *beta* diversity. Within community diversity (*alpha*) may also be affected by large herbivores, depending on grazing pressure as well as abiotic growing conditions. However, it is so far unclear how exactly and at which spatial scales the potentially interactive effects of abiotic conditions and grazing animals shape the patterns of plant communities in the arctic tundra.

Here we studied the structuring effects of free-ranging, domesticated sheep on plant community diversity at multiple spatial scales. We conducted a large scale vegetation survey in Icelandic tundra areas. We compared glacially eroded U-shaped valleys with abandoned sheep farms to comparable sheep grazed valleys. We stratified sampling to entities of topography within the valleys and hereby distinguished between “macro-topography” (high and low elevations), “meso-topography” (convex and concave terrain forms nested within macro-topography) and “micro-topography” (convex and concave terrain forms nested within meso-topography). We sampled plant communities using the point intercept method in 40 x 40 cm plots within entities of meso-topography. We further achieved information on the abiotic growing conditions by taking soil samples at the meso-topographical scale.

Preliminary results indicate that sheep grazing reduced community differentiation (*beta* diversity) on a meso-topographical scale. However, these effects seem to be only pronounced in valleys with rather fertile conditions. Further exploitation of our data set that covers scales relevant for sheep management, can inform decision makers and provides information relevant to the preservation of plant diversity in grazed low arctic tundra areas.

O16 - The diversity of bryophytes in polygonal landscapes along a transect in Northern Siberia

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Polygon networks are the typical landscape features in the arctic Siberian lowlands characterized by permafrost conditions. Due to the harsh weather conditions, bryophytes are the dominate plants in polygonal landscapes, covering approximately 100 % of the surface, and in water-filled ponds. The storage conditions for organic matter are favorable in this cold and wet climate, thus this plant group could give information about the past-environmental. We investigate the diversity of bryophytes in eight low-centre polygons in the Chatanga River region along a transect from the forest tundra ecotone to the treeless tundra to establish mosses as a palaeo-environmental proxy.

In every polygon, we analyzed one transect section over the whole structure (from rim to rim), using a traditional vegetation survey approach and compare them with statistical methods. Additionally, parameters like elevation, thaw depth, and water level were recorded. Estimations of river impact were included, respectively.

The occurrence of bryophyte species is not only a question of wet or dry conditions and we found different associations in the records of opposite rim sections within a polygon. Thus, we infer that the composition of the polygon moss flora is driven by other internal and external factors, such as climate.

O17 - Effects of small-scale spatial variation in density of *Jacobaea vulgaris* on plant-soil interactions

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Plant-soil feedback is the process in which plants influence the biology, chemistry and structure of the soil they grow in, which in turn, can lead to changes in the performance of plants that grow later in the soil. Several studies have argued that plant-soil feedback is related to the density of a plant species, for instance due to the build-up of species-specific pathogenic soil microorganisms. However, this is typically studied in the greenhouse with soil inocula consisting of mixtures of soil samples from different locations. Therefore, the potential for local, small-scale spatial variation in plant-soil interactions is often ignored. We examined whether growth of the early successional species *Jacobaea vulgaris*is related to spatial variation in its density within a single field. We selected plots with high and low *J. vulgaris* density and recorded *J. vulgaris*, other vegetation and soil chemistry characteristics. Soil from the plots was used in a greenhouse bioassay to study the growth of *J. vulgaris*, both in pure field soil and in sterile soil inoculated with a small part of field soil.

Our results show that there is spatial variation in local plant-soil interactions of *J. vulgaris* and that this variation is related to plant density. We show a negative relationship between plant density in the field and plant growth in the bioassay, probably due to the density-dependent build-up of soil pathogens. However, other factors such as nutrient availability and seed density are also important for spatial variation in density of *J. vulgaris*. Soil-mediated density effects were less strong in pure field soil, compared to inoculated soil, due to confounding effects of soil nutrients in pure soil. Our research shows that it is important to include local, small-scale spatial variation in plant-soil interactions to increase our understanding of the role of these interactions in affecting plant performance and community dynamics.

P1 - Phylogenetic and phylogeographic patterns of the genus *Oophytum* (N.E.Br.) in the Knersvlakte, South Africa

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The genus *Oophytum* growing on quartz fields in the arid Knersvlakte of the Succulent Karoo Biome (South Africa) is a local endemic genus of the Aizoaceae family and has been divided based on morphological features by Ihlenfeldt (1978) into two species *O. nanum* and *O. oviforme*. The two species with partly overlapping distribution areas prefer different habitats in stone coverage and steepness of the slope. To reconstruct the differentiation of these two species on genetic level, ten individuals out of ten populations of the distribution area were sampled (six populations of *O. nanum* and four populations of *O. oviforme)*. On the basis of the AFLP data from nine populations cluster analyses and a principal coordinate analysis (PCO) could be performed.

Instead of differentiation into the two species a geographical distribution pattern a separation of the investigated populations into three groups has been identified in PCO as well as cluster analyses: a) one group formed by the two most south-western populations, completely separately from the other two groups, b) one group with a north-south distribution, c) the other formed with an east to west distribution. Similar results could be found in a study with multigene sequence analysis based on *trn*G-*trn*S and *mat*K sequences.

Driving factors or combination of factors, which might cause the expression of the phenotypes of the two species and the genetic structure of the three population groups could not be identified up to date. In addition to the differences in total quartz stone cover and steepness of the slope adaptation to differing micro-climatic conditions might play a role. Gene flow within the distribution area can be enhanced or limited by geomorphologic structures in the landscape (e.g. drainage basins, ridges).

Session 21 - Mixed Forest Ecology

Chairs: Ann-Catrin Fender, Michael Köhler, Dirk Hölscher

O1 - Overall biodiversity response to forest management may be predicted by silvicultural management intensity

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Biodiversity in forests is known to be affected by forest management. However, the effect of forest management on biodiversity is probably as multifaceted as biodiversity and forest management are. We assume that the effect of forest management might not be covered by proxies, as done in many previous studies on forest biodiversity. Such proxies are for example (1) lumping forest stands into a few categories such as even-aged, uneven-aged and old-growth stands or management with and without tree species change, or (2) using attributes of forest stand structure, which are an outcome of forest management history.

We hypothesize that forestal land use intensity (FLUI), perceived as a measure that summarizes forest management, predicts overall biodiversity better than single measures of forest stand structure or indices of stand structural complexity. We present a new measure of forestal land use intensity for central Europe, the silvicultural management intensity (SMI). We analyzed the relationship of SMI to (i) broad forest management types, (ii) other measures of FLUI, (iii) forest inventory properties of stands, (iv) forest stand structural attributes, and (v) forest stand structural complexity indices, which additively combine stand structural attributes, based on a total of 42 forest plots from four regions of Germany. We further analyzed the response of organisms to different measures of forest management and stand structure based on a subset of 12 stands located in Southern Bavaria and by considering 35 trophic-functional guilds (33 animal and 2 plant), covering all four primary trophic levels.

SMI was found to be correlated with several measures of stand structure, but mainly separates stands based on species composition and stand age. We show that SMI better predicts overall biodiversity than single attributes of forest stand structure or stand structural complexity indices. For SMI a higher number of significant relationships to (i) trophic-functional guilds per biodiversity measure and to (ii) trophic-functional guilds across biodiversity measures were found. Additionally findings were (iii) more robust when subjected to jack-knife approach.

We suggest to consider FLUI measures in analyses on overall biodiversity response to forest management.

O2 - Accurate modeling of tree mortality is key for simulating forest dynamics under climate change

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Forest succession models hold promise for predicting future forest dynamics under climate change as they are applicable over a wide range of sites and species under different climatic conditions. However, to date rather simple parameterizations for fundamental ecological processes like tree mortality are implemented in most models, probably due to scarce or missing data. A better modeling of tree mortality using ecologically sound, mechanistic approaches would be crucial for making reliable projections of future forest development.

We evaluate several tree ring- and inventory-based mortality functions by implementing them in the forest succession model ForClim. We applied these model versions at sites in the Swiss Alps, a region that is expected to be particularly sensitive to climatic change. Simulation results show that ForClim is highly sensitive to the exact formulation of the mortality submodel. Regarding simulated tree species composition and basal area, tree-ring based mortality functions appear to be better suited for forest succession models than the currently available inventory-based functions. However, tree-ring based models are available for a few tree species only, thus limiting the application of succession models. Thus, a key challenge is to derive reliable mortality models based on tree-ring data for a broader suite of species, e.g. by employing the concept of plant functional types.

O3 - Ecotype mixing in forests: The interplay of self-thinning and the portfolio effect

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Growing conditions for trees are expected to change drastically with climate change. The introduction of presumably better-adapted populations (i.e. ecotypes) from other locations is therefore currently in discussion. One strategy is to grow the ecotype which is best adapted to a future climate. This ecotype will provide optimal yields. However, this strategy ignores uncertainties in climate projections and the long-term performance of certain ecotypes.

One way to deal with uncertainty frequently applied in economics is ‘conservative bet-hedging’ aiming at benefiting from the portfolio effect. The portfolio effect stabilizes yield, however, it also decreases chances of high yields. In contrast, the strategy to increase within-stand diversity by 'ecotype mixing' increases the set of possible outcomes of stand biomass and thereby counteracts the portfolio effect. To understand the consequences of increased stand diversity by ecotype mixing, it is crucial to understand the interplay of self-thinning and the portfolio effect. The present study points to the opportunities in forest management compared to classical product management. In order to evaluate the combined effects of increased stand diversity, self-thinning and the portfolio effect on stand biomass and correlated yield, a strategic simulation model inspired by empirical data from common garden experiments was applied. Our simulations suggest that the drawback of the portfolio effect of lower chances of high yield is attenuated by the natural process self-thinning. This implies that the drawback of the portfolio effect of lower chances of high yields is less than in the classical case of economic product management. Additionally, self-thinning counteracts the effect of higher uncertainty of yield in stands with higher within-stand diversity caused by ecotype mixing.

O4 - Effects of tree species diversity on water consumption and productivity of five deciduous tree species

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The effects of biodiversity on ecosystem functions have mostly been studied with respect to productivity and resource exploitation. However, species complementarity affecting water consumption has received much less attention, especially for forests. This study aimed to analyze species effects and mixing effects on water use and productivity of five deciduous tree species in a common garden experiment.

We hypothesized tree species diversity to increase productivity due to complementary water use and thus, to enhance plant transpiration. Saplings of *Acer pseudoplatanus, Carpinus betulus, Fagus sylvatica, Fraxinus excelsior* and *Tilia cordata* were combined in mono-cultures, three-species mixtures and five-species mixtures. Transpiration rates were estimated using a gravimetric approach. Tree biomass and morphological attributes were determined by harvesting.

Transpiration rates, normalized by leaf area, did not differ between levels of tree species diversity (1, 3, 5 species). Between mono-specific cultures transpiration differed slightly (*T. cordata* > *C. betulus*). Summarizing all species, variances in productivity were not caused by tree species diversity, but differences in root morphology (maximum root length) were detected between mono- and mixed-cultures. Regarding single species, only *T. cordata* performed higher productivity with increasing tree diversity.

A general transpiration-productivity relationship was supported by our data, whereas tree species diversity did not affect water consumption. Hence, no evidence for species complementarity in water use could be found. According to productivity, the benefit of *T. cordata in mixed-cultures*

supports findings by others, indicating this species to play a distinguished role for the resource dynamics indeciduous mixed forests.

O5 - Does tree species richness affect coarse woody debris decomposition?

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While the influence of biodiversity on many ecosystem functions is now well established, little is known about the effects of biodiversity on wood decomposition. Forests worldwide capture 10 – 20% of their carbon (C) in coarse woody debris, comprising a significant C and nutrient pool. Diversity may affect stocks of woody debris and its decomposition rates by altering the decomposer microenvironment, the substrate quality and/or the diversity and abundance of decomposers. We studied the impact of woody species richness and its potential interaction with decomposer group identity on wood decomposition.

Our study was conducted in a subtropical evergreen forest in southeast China, where 27 permanent study plots have been established to form an orthogonal gradient in stand age and woody plant species richness. We deployed freshly cut and uniform sized stem wood from two dominant tree species (*Schima superba* and *Pinus massoniana*) and measured decomposition rates after one and two years, respectively. To quantify the interaction of the design variables with different decomposition agents, i.e. fungi alone versus insects and fungi we used mesh bags which were either accessible or inaccessible for invertebrates. We standardized decomposition rates for climatic and environmental variables in a hierarchical Bayesian modeling framework, and evaluated the effect of plot-specific tree species richness and its interaction with insect accessibility on decomposition rates.

Decomposition rates varied significantly between *Pinus massoniana* and *Schima superba*, with the gymnosperm decomposing faster than the angiosperm. Insect exclusion did not alter wood decay of either species. Pronounced differences in decay rates could be found between plots for all species-treatment combinations in the second year of the experiment. We discuss the influence of plot-specific tree species richness and functional diversity on wood decomposition rates and show how these relationships are mediated by decomposer group abundance. Our results help to improve the mechanistic understanding of C and nutrient sequestration and cycling with respect to dead wood in forests.

O6 - Allometrical acclimation of European beech to intra- and inter-specific competition with Douglas-fir at the crown level

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In the Palatine Forest, a 60-year-old pure stand of *Fagus sylvatica* was compared to a neighboring mixed stand with *Pseudotsuga menziesii*. Although the Douglas-fir trees are up to fifteen years younger, they overgrow the beeches by several meters. The beeches respond with enhanced height growth and lower stem increment in the mixed stand. The aim of the study was to examine the underlying competitive strategies of the beech which are evoked by limiting space and light availability.

In the pure and the mixed beech stand, phenological leaf and shoot development, space-related resource investments and biomass partitioning between photosynthetic, non-photosynthetic and regenerative organs were investigated at the scales of single shoots and leaves up to small branches along a vertical crown gradient. The relative seasonal irradiance at each sampling spot was evaluated through hemispherical photography. On each crown position, a PAR-sensor was installed to monitor the dial and seasonal variations of photon flux density and to calibrate the evaluation of hemispherical photographs. Photosynthetic performance was assessed seasonally by means of porometric light response and A/Ci curves. Transpiration was measured using sapflow sensors at the branch level.

Partial shading by Douglas-fir caused an allocational alteration in the sun crown of the mixed stand: Biomass investigations were shifted to shoot development at the expense of crown volume occupation. Significantly enhanced specific leaf area did not compensate this loss in space occupation efficiency. In contrast, shoot growth was driven by canopy gaps in the lower and middle crown. The different responses of the sun and the shade crown to the cumulative light availability may be ascribed to the differing dial and seasonal light distribution patterns in the upper and lower canopy. The strong dependence of photosynthetic parameters on specific leaf area and foliar nitrogen concentration did not vary between the pure and mixed stand despite a later senescence of the sun leaves in the mixed stand due to lower irradiance. Our results quantify the occurring competition effects and the resulting costs and benefits.

O7 - Effects of different forest management regimes on plant community structure and biodiversity of natural secondary forests in Danqinghe Forestry Farm

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We studied the different effects of extensive forest management regime and target tree management regime on plant community structure and biodiversity of natural secondary coniferous forest, broad-leaved forest and mixed forest in Danqinghe Forestry Farm which locates in Harbin, Heilongjiang Province, no disturbance forest stand was selected as reference. The results showed that: 1）Compared with extensive forest management regime and no disturbance, the basal area of the first canopy layer under target tree management regime was the highest, proportion of basal area was 95.00%, 90.00%, 87.00% in coniferous forest, broad-leaved forest and mixed forest respectively. The basal area of the second and third canopy layer under target tree management regime was the lowest. All of these implied that stand under target tree management regime have the best canopy structure. 2)The average stand density under target tree management regime（408-858 tree · hm-2） was significantly lower than that under extensive forest management regime (992-1 917 tree · hm-2)（P＜0.05）, there was no difference in average basal area. Average tree height（11.8-14.9 m） and DBH（15.94-27.34 cm） under target tree management regime were significantly higher than that under extensive forest management regime(tree height is 7.1-11.0 m and DBH is 10.18-19.00 cm)（P＜0.05）. 3）Above 60% of trees under extensive forest management regime and no disturbance regime were small-diameter tree（DBH smaller than 12 cm）, but above 60% of trees under target tree management regime were middle-diameter tree（DBH 14-18 cm）and large-diameter tree（DBH above 20 cm）.4）Diversity in tree layer under extensive forest management regime was higher than that under target tree management regime; exception of broad-leaved forest, diversity in shrub layer under extensive forest management regime was higher than that under target tree management regime; while diversity in herb layer under target tree management regime was the highest. 5）These findings confirm extensive forest management regime purse more timber production and neglect ecology requirements, while no disturbance regime just focus on ecology and neglect the requirement in using forest resources, neither of them can meet the human's needs. Target tree management regime can improve community structure, get more economic benefit and balance ecological functions simultaneously which comply with objective of sustainable forest management.

Key words：natural secondary forest；forest management regimes；community structure；plant biodiversity Xingyun Liang[1], Youjun He[2], Pu Zhang[2], Jiantao Rong[3], Lin Qin[1], Zhiyong Li[2]

O8 - Phenotypic plasticity in *Phratora vulgatissima*: the willow species affects odour of beetles and beetle orientation to host plant cues

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Knowledge of phenotypic plasticity in infochemicals use by herbivorous insects is essential for developing biological control strategies, especially in mixed forests or plantations. The willow leaf beetle *Phratora vulgatissima* is a main pest in mono- and polycultures of willow species. The beetle uses a combination of volatile cues from conspecifics and host plants for aggregation. Here we studied whether the willow species upon which the beetles feed affects (I) the volatiles emitted by the beetles, (II) the electrophysiological antennal responses of the beetles to volatiles released from conspecifics, and (III) the behavioural responses of the beetles to host plants.

Adult beetles were fed either with leaves of *Salix viminalis* (V-beetles), a species with a low content of the phenolglycoside salicin, or with leaves of *S. dasyclados* (D-beetles), a species with high concentrations of salicin. The results of our studies were as follows: (I) Analyses of the odour emitted from beetles by coupled gas chromatography – mass spectrometry revealed that the beetles released saturated, short-chained carboxylic acids (C6-C9), aldehydes (C7+C9), benzaldehyde, and salicylaldehyde. Salicylaldehyde was released only by D-beetles. (II) Electroantennographic (EAG) studies showed that the beetles' antennae responded to carboxylic acids and aldehydes. D-beetles were more sensitive to salicylaldehyde than V-beetles. (III) Four chamber olfactometer bioassays showed that D-females preferred the odour of *S. dasyclados* and the bouquet representing the natural GLV-ratio of this species over the odour of *S. viminalis* and the respective GLV-ratio; V-females did not differentiate between any of the odours offered. Further laboratory bioassays provided evidence that both D- and V-females showed feeding and oviposition preferences for twigs of *S. viminalis* over *S. dasyclados*.

Hence, both the odour emitted by *P. vulgatissima* beetles as well as the beetles´ behavioural responses to host plant volatiles showed phenotypic plasticity and were dependent on the willow species experienced during the adult stage. In contrast, the beetles preferred *S. viminalis* in feeding and oviposition assays, irrespective of adult host plant experience.

O9 - Does tree diversity change forest edge effects on carabid beetle communities?

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Plant biodiversity has been shown to sustain and stabilize biodiversity patterns such as higher trophic level consumers. Central European forests are highly fragmented, while tree diversity effects can be expected to change negative edge effects on community composition of insects.

Our study is the first to independently assess the relative importance of tree biodiversity vs. edge effects in forests.

We focused on ground beetle (Carabidae) species richness and community composition in Germany´s largest non-fragmented deciduous forest, Hainich National Park in Thuringia.

We addressed two main questions:

1. How far do edge effects reach into the forest interior?
2. Is there an interaction among edge effects and tree biodiversity effects?

We selected forest stands differing in tree species richness (species rich vs. beech-dominated) and set up 12 transects reaching from the forest edge up to 500m into the forest interior. Pitfall traps were installed at different distances to the forest edge.

We recorded more than 8000 ground beetle specimens belonging to 52 species. Tree species richness had an overall positive effect on ground beetle species richness and affected community composition. Carabid community composition also depended on distance to the forest edge. Responses of single species to distance to the edge differed with tree species richness.

We conclude that both tree species composition and forest fragment size need to be considered in conservation area planning.

O10 - Agricultural intensification neutralizes effects of tree diversity on plant-herbivore interactions in subtropical forests, South Africa

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Local habitat characteristics and regional landscape changes are equally important for the composition, structure, and interactions of forest communities. Yet, potential interactive effects of small- and large-scale patterns have rarely been addressed. Further, species-specific traits of interacting species have largely been overlooked.We therefore studied the combined effects of (1) local forest tree diversity and (2) regional agricultural intensification on plant-herbivore interactions from a species level perspective in subtropical indigenous forests in southern KwaZulu-Natal, South Africa.

Interaction diversity of plant species with herbivores decreased with increasing tree diversity. The magnitude of this effect diminished with agricultural intensification being absent in forests with highest proportion of agriculture in the surrounding landscape. Specialization of herbivores per plant and leaf area loss (LAL) showed no response to tree diversity or agricultural intensification.

High local tree diversity may provide a larger set of potential host plant species resulting in lower interaction diversity per focal plant species. Though agricultural intensification seemed to neutralize this effect of associational susceptibility. Hence, this study supports that environmental effects on different spatial scales do interact and agricultural intensification may interrupt effects of local habitat features. Although we could not detect environmental effects on specialization of herbivores and LAL, changes in plant-herbivore interaction patterns may still have serious implications for plant performance such as growth and reproduction as well as forest regeneration in the long-term.

O11 - A (counterintuitive) role of habitat fragmentation in temperate forests: Forest edge promotion of food web complexity in plant-herbivore networks.

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The worldwide biodiversity crisis is driven primarily by anthropogenic habitat fragmentation, resulting in loss of species, ecosystem function and ecosystem services as well as in a simplification of communities and species interactions. A substantial proportion of global terrestrial landscapes are heavily affected by forest fragmentation, which means habitat loss, isolation and edge creation. The bulk of research is currently focused on the tropics, although the history of forest fragmentation dates much farther back and has been most exhaustive in the European temperate zone. Herbivores and plants form the basis of the trophic pyramid and fulfill fundamental roles in ecosystems in terms of ecosystem function. Forest fragmentation has been shown to alter interactions between these two organismic groups, but studies on the patterns of the interaction networks they form are still scarce. Hence, we studied the effects of forest fragmentation on plant-herbivore interactions in a hyper-fragmented forest landscape in SW Germany (North Palatinate Uplands) by using the network approach. The question was, whether forest fragmentation affects the diversity of plants and herbivores, their interaction complexity and the complementarity of herbivore assemblages. We sampled the woody understory of forest edges, fragments and interior plots (0.1 ha, 12 plots per habitat). Even after excluding tourists we found a very diverse fauna of insect herbivores, totaling 151 taxa in at least 31 families and detected over 800 trophic interactions. Diversity of plants and

herbivores was highest in forest edges, as compared to interior habitats. Furthermore, interaction networks showed both a higher interaction complexity and trophic complementarity in edges, probably as a result of higher host diversity, promoting herbivore diversity and niche availabilities. Forest interiors, on the other hand, harbored highly simplified assemblages, primarily of generalist herbivores. Our findings can be explained by ecotone and edge-induced effects as well as by sustained release of edge habitats from forest management. Additionally some specialist herbivores (e.g. aphids and psyllids, *Sternorrhyncha*) showed preferences for fragmentation-affected habitats, possibly because of dispersal benefits. We conclude that, due to the long history of silvicultural use of Germany's forests, fragmentation-affected habitats may serve as refuge for herbivore diversity and its ecosystem functions.

O12 - Island vegetation changes in Amazonian lakes formed by hydroelectric plants

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In Amazonia, many large rivers have already been dammed or are in various stages of planning in order to provide energy from hydroelectric plants. Once dammed, rivers turn into huge lakes which flood the original vegetation in the former river basins. Mountains are left as islands in these artificial lakes. The former vegetation suffers from the strong impacts of fragmentation, including microclimatic changes (e.g., artificial edge habitats, erosion, desiccation from wind, and altered rainfall patterns) as well as effects of flooding on previously unflooded soils. These conditions lead to high mortality rates of indigenous trees unless they are pre-adapted to wet conditions and to shifts in floristic composition. In this presentation we analyze the short-term responses from three sites in the floodplains of the Tapajós, Xingu and Tocantins Rivers in Eastern Amazonia. The results show that tree species of the highly specialized pioneering formations are clearly distinct between the three river basins although they are not very distant from each other and environmental constraints are very similar. With only six out of 74 species occurring in the three inventories, the majority of tree and shrub species is restricted to each one of the rivers, indicating a high degree of local endemism in these regions. Different species occupy similar environmental niches, alternative designs of equal fitness occur in similar environments making these fragile ecosystems of pioneering formations highly valuable. Conservation plans must therefore consider the complementarity of species when decision on where to place conservation units are taken. If this is not considered for conservation strategies, the original biodiversity will be lost irreversibly, and it is impossible to compensate for it in other places.

P1 - Modelling complementary resource use among plants

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The idea behind complementarity in resource use is that niche partitioning in multispecies stands leads to some kind of positive effects. To answer the question whether these effects come from species diversity or species identity, it is necessary to compare mixed stands with respective monocultures, which in consequence leads to a high number of treatments. While most studies used biomass production of stands to quantify the effects of complementarity, the facts that complementary resource use does not necessarily lead to a higher productivity of mixed stands compared to monocultures has been neglected. We suggest a new approach which focuses on the uptake of resources and allows the calculation of a complementarity index, thus describing the portion of resources captured by the stand. In this context a theoretical mechanistic based model should help to identify the underlying processes of complementary resource use and the relationship between diversity and complementarity. To simulate the processes of complementary resource uptake by stands with different species we applied NetLogo 4.1.3, which is an agent-based programming language with integrated modeling environment. Inputs to the model were traits to describe the amount and uptake rate of resources (water, nutrients, light), the area influence by resource capture, and the physiological and morphological plasticity. Stand variables were used to describe the spatial distribution of the plants and the percentage of each species in a mixture. The model enabled to simulate stands with up to 10 species and 3 resources at a time. A complementarity index (CI) was calculated with the percentage of resources captured in a stand, compared to all resources in the system. A similarity index (SI) was used to specify the similarity between the traits of the species in a stand. By comparing these two indices with the number of species in a mixture, it was possible to quantify the effects of complementary resource use for multispecies stands and multiple resources.

P2 - Can the neutral theory explain beech dominance in temperate species-poor forests?

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A major aim of near-natural forestry is to maintain or increase biodiversity. However, longer time series in National Parks seem to indicate that unmanaged temperate forests become dominated by beech. Even starting with a low proportion, beech excludes nearly all other species over time. This is largely attributed to the ecological properties of beech trees, most of all, its shade-tolerance. Hubbel's Neutral Theory has proven its values many times in species-rich tropical forests. But could it also explain dominance of a single species in a species-poor system, such as beech in a temperate forest?

We developed an individual based model in NetLogo. Model scenarios differed in the initial number of species (starting at a two-species system). In order to test the establishment or extinction of species due to stochasticity alone, species had no ecological property. First results indicate that, even after a longer time (e.g., 200 years), some constellations of mortality and speciation (or immigration) rates can lead to a small local species community (e.g., 35 species), even if the meta-community has an unlimited species pool. This hints towards the importance of stochastic processes for biodiversity maintenance even in temperate forests, where properties of a local community might now be regarded as results of the ecological potential of a species alone.

P3 - Functional traits, palatability and induced defence of beech and maple saplings

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Selective browsing of tree saplings by roe deer is known to alter tree species composition and diversity in mixed beech forests in Germany. This “demixing” effect of browsing is detrimental to sustainable forestry, which aims at a high tree species diversity to lower risks of losses e.g. due to insect outbreaks or climate change. Numerous studies report differences in browsing intensity of tree species, however, little is known about the palatability of the species in relation to differences in their functional traits. Furthermore, insect herbivory is well known to induce defence in leaves, whereas there is a lack of knowledge about induced defence in tree saplings as a response to mammalian browsing .

To address these open questions we studied saplings of *Fagus sylvatica* and *Acer pseudoplatanus* in the Leipzig floodplain forest. First, to examine differences in chemical composition and thus quantify palatability of the saplings, we analysed protein content, soluble sugars, hormones (jasmonic and salicylic acid) and phenols of apical buds. Second, to investigate the saplings’ response to browsing, we conducted an experiment, in which we simulated browsing by either clipping the saplings’ apical buds or by clipping and additionally applying roe deer saliva to the cut surface. After 2 and 48 hours, respectively, we sampled the saplings’ lateral buds and analysed changes in the plants’ chemistry.

We expect that i) *F. sylvatica* has a lower content of soluble sugars and proteins, but higher content of tannins than *A. pseudoplatanus* and is hence less palatable to roe deer. We also assume that ii) both tree species show a change in hormone concentrations after being browsed.
Our findings will contribute to a more mechanistic understanding of selective browsing and of chemical defence in saplings, both as functions of the saplings’ specific traits. This should facilitate future predictions of sensitivity to browsing based on species’ functional traits.

P4 - Effects of species identity and root orders on fine root biomass and morphology of six temperate deciduous tree species

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Species diversity has often been suggested as an important factor influencing biomass and productivity of plant communities. In this context, several studies have been conducted to investigate the impact of species diversity on the fine root system of temperate deciduous forests. As in most studies diversity was not found to be a major factor influencing below-ground biomass and production, we attempt to elucidate the role of species identity effects on biomass and morphology of fine roots with a species focus on root branching orders. Our study site is situated in Hainich National Park, an old-growth deciduous forest in Thuringia, Germany, where we examined six deciduous tree species: *Carpinus betulus, Fagus sylvatica, Acer pseudoplatanus, Acerplatanoides, Tilia cordata,* and *Fraxinus excelsior.* In total we chose 48 tree pairs of each species consisting of 8 replicates per species. Fine roots were extracted and the species were determined according to morphological traits. Living and dead fine roots were separated for determining root biomass and necromass. In addition, morphological root order-related traits were measured for each species with WinRhizo software.

Our study reveals marked differences in morphological traits among tree species as well as among soil layers and root orders. For fine root biomass we could not demonstrate pronounced species differences in this mixed forest, but fine root necromass showed significant differences between several of the species.

In conclusion, fine root necromass, fine root morphology and root order-related traits of the five species were found to depend largely on the species in this deciduous forest which should influence root function and belowground C cycling.

P5 - Soil water uptake depth of trees assessed by water stable isotope analyses (δ2H and δ18O) - a method test

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Stable isotopes of water (^{2}H and ^{18}O) are often used to assess plants' water uptake depths, and thus applied as a test for species complementarity, in cases where an isotopic gradient has developed in the soil profile. It is accordingly assumed that fractionation of O and H isotopes follows the same pattern during evapotranspiration, with the consequence that the isotopic composition of a plant's water source matches that found in the xylem water. However, in a field study on tree water uptake on clay soil above limestone parent rock, we observed a difference in the δ^2H-$\delta^{18}O$ ratio between the water in the soil and the xylem. Thus, when both isotopes were used independently in a visual "best match" approach for water uptake estimation, results were conflicting. Therefore, a series of laboratory experiments was conducted in order to investigate whether and to what degree soil moisture, clay content and soil calcium carbonate might have influenced the isotopic composition of extracted water. First, dried soil samples varying in clay content were rewetted with different amounts of water of known isotopic composition. Secondly, we removed soil carbonate from a subset of samples prior to rewetting. Water was extracted from samples via cryogenic vacuum extraction. We found significant effects of all three factors on the isotopic composition of extracted water. In addition, the presence of carbonates in the soil was found to significantly alter the isotopic composition of $\delta^{18}O$ in the added water while the δ^2H was not affected. As a conclusion, we recommend that results on plant water uptake studies based on isotope fractionation are treated with caution, particularly for clay and carbonate rich soils with low water content. Hence, water isotope studies should not solely rely on the analysis of only one isotope, lest possible differences in the δ^2H-$\delta^{18}O$ ratio might go unnoticed.

P6 - Faecal pellet count as a tool for estimating habitat choice of red (*Cervus elaphus*) and roe deer (*Capreolus capreolus*)

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To develop a new management for red and roe deer in the conservation area Lüneburger Heide a faecal pellet group count was conducted in order to study the distribution of deer. The aim of the study was to investigate factors, which may have a positive or negative effect on the habitat choice of red and roe deer. The influence of habitat structure, like plant species, tree frequency, tree height, under vegetation and distances to rivers as well as human influences like streets, settlements or houses, raised hides and mineral licks were investigated. The number of fecal pellets of red and roe deer were significantly correlated ($r = 0{,}122$, $p = 0{,}000$, $n = 1309$). However, our results reveal some differences in the habitat choice of both species:

Red deer preferred forest areas with young trees, especially birches, beeches and rowans. Tree density had no effect on red deer, but large scale forest patches were preferred. Furthermore, forest areas with a high coverage of blueberries were chosen. Forest areas with small roads and paths were avoided, whereas bigger roads and freeways had no significant effect on the habitat choice of red deer. Roe deer mostly used forest areas that offer a high tree density mostly consisting of young trees. The preferred tree species were birch and spruce. Just like red deer, roe deer prefers forest areas with a high coverage of blueberries and additional forest areas with a high coverage of blackberries and deadwood were chosen. Moreover, roe deer avoided roads and freeways. In contrast to red deer, smaller roads and paths had no effect on the habitat choice of roe deer. Significant more feces from red and roe deer were found near mineral licks. On the contrary, there weren't significantly more or less feces found in the proximity of raised hides. In addition settlements or houses and rivers had no significant effect on the habitat choice of both, red and roe deer.

The results of our study demonstrate that faecal pellet count can be a useful and cost-extensive tool to investigate habitat utilization of red and roe deer.

P7 - Spatial influence of mixed broad-leaved trees on ground beetles (Carabidae) in mono-cultural pine forests

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The poor and dry soils in the German lowlands are mostly dominated by large homogeneous pine forests. They are characterized as single-layered, even-aged and poor in diversity of flora and fauna. Increasing risks caused by climate change and broader objectives of forest management strategies for ecosystem services have increased the importance of tree species mixtures. For regions dominated by pine forest mono-cultures, the increase in tree species mixtures is equal to an increase in the degree of diversity and naturalness. It is assumed that single oak and birch trees already imply positive changes in the heterogeneity of soil or micro-climate conditions, and for the diversity of flora and fauna. Such effects of tree mixtures are strongly dependent on tree position, and consequently are affected by the spatial distribution of those trees (e.g. aggregated *versus* evenly distributed mixtures). Spatial influence zones are used to quantify abiotic and biotic effects of mixtures for different stand conditions. In the past the family of ground beetles was used as an indicator for adaptation to different tree species and stand structures, but very little spatial information is available to quantify spatial relationships between tree species and distribution of different ground beetles. In a homogenous pine forest with isolated oak and birch trees 123 pitfall traps were placed on a grid of 15 x 15 metres over an area of about 3 ha for mark-recapture study. The most important findings of the study confirm the assumption of species-specific spatial distributions of ground beetles caused by different degrees of adaptations to broad-leaved trees. Some species (e.g. *Carabus coriaceus*) are strongly dependent on the admixtures of broad-leaved trees, while others (*Carabus violaceus*) were significantly more common in the pine-dominated areas of the stand. The statistical tool point processes was used to quantify the effects caused by admixed oak and birch trees.

Session 22 - Biogeochemical Cycles in a Changing Environment

Chairs: Lutz Merbold, Albin Hammerle, Martin Wattenbach

O1 - Canopy position influences the deviation of plant-transpired water vapor from isotopic steady state

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The ^{18}O composition ($\delta^{18}O$) of ecosystem water pools is frequently used to determine the pathways of water movement through terrestrial ecosystems. These methods commonly assume that the isotope composition of water vapor transpired by plants equals that of source water, termed isotopic steady state (ISS). Indeed, during the day the $\delta^{18}O$ of leaf water ($\delta^{18}O_L$) often closely approximates predictions of ISS models when they incorporate Péclet effects. Until the recent development of isotope ratio infrared spectroscopy (IRIS) instruments, testing whether $\delta^{18}O$ of transpired water ($\delta^{18}O_{trans}$) actually equals the $\delta^{18}O$ of source water has been difficult. Here we coupled an IRIS instrument to a plant gas exchange system installed in the Kranzberger Forst in southern Germany to measure variation in $\delta^{18}O_{trans}$ and the rate of change in leaf isotopologue storage (isostorage) of sun and shade leaves of *Fagus sylvatica* under naturally varying conditions. $\delta^{18}O_{trans}$ varied up to ~12 ‰ in sun leaves and up to ~20 ‰ in shade leaves during daylight hours. Leaf water isostorage of sun leaves, which showed both enrichment and depletion of $\delta^{18}O_L$ during the day, was more variable than the isostorage of shade leaves due to much higher transpiration rates of sun leaves compared to shade leaves. Additionally, we measured variation in $\delta^{18}O_L$ and compared this to ISS model predictions based on measurements of $\delta^{18}O_{trans}$. For plants with large and complex crowns, assuming ISS transpiration should only be done cautiously.

O2 - Carbon dynamics in Western Siberian soils under climate and land-use change

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Soils of the Western Sibirian Lowlands have a tremendous contribution to the global carbon cycle. Much of the territory is covered by peaty soils or Chernozem related soils which store huge amounts of terrestrial carbon. Human impact has transferred many of the natural mineral soils to agricultural fields or taken the mires into usage for peat extraction. As part of the BMBF-funded project

"SASCHA" we are searching for the main drivers that alter carbon dynamics in a changing environment. The Study area is located in the Tyumen Oblast and displays a region which is situated between the forest-steppe and pre-taiga ecotone. Climate-scenarios propose an increase of temperature and a decrease of precipitation for this region. This will automatically lead to a higher proportion of soils which are capable for agricultural use.

In three test areas of 400 km² which cover the main climatic gradient, soils are sampled on plot scale according to land-use type and soil type. The soil samples are analyzed for TOC, N, K and P. At the end of the project a model will be defined which compares different land-use strategies with respect to their impact on carbon sequestration and release.

O3 - Changes of seasonal ecosystem respiration patterns after 3 years of snow manipulation in high Arctic tundra

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The future of tundra ecosystem respiration (ER) tempo-spatial patterns is unknown. Warming will accelerate C mineralization rates, but the importance of winter warming on vegetation type is uncertain and long-term winter-manipulation studies are scarce.

We revisited a snow fence experiment in Svalbard and tested if ER patterns have changed after 3 years of additional winter soil warming.

We found that (1) warmer soils during winter resulted in higher ER rates during winter, which is expected due to an increase of reaction rates of biotic CO_2 producing processes with temperature; (2) Summer ER rates were lower in winter warmed plots in 2010/11, but not during 2007/8, one year after establishment of the experiment. This can be explained by long-term depletion of labile C sources and a shift to recalcitrant substrates with inherently slower reaction rates; (3) Species-specific ER rates were not significantly different from each other, although biomass stocks were different. This suggest a strong species-specific influence of chemical composition of substrate deposition on ER rates, rather than biomass content alone.

We conclude that (a) increasing annual C losses caused by winter warming will be partly compensated for in the long run by initial losses of favorable substrates; (b) climate change induced shifts of plant species composition and connected biomass quality will be of major importance to long-term changes in tundra ER rates.

O4 - Cryptogamic covers: a forgotten component of the global carbon and nitrogen cycles?

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Cryptogamic covers are composed of cyanobacteria, green algae, lichens, bryophytes, fungi and bacteria in varying proportions. As cryptogamic ground covers, comprising biological soil and rock crusts they occur on many terrestrial ground surfaces. Cryptogamic plant covers, containing epiphytic and epiphyllic crusts as well as foliose or fruticose lichens and bryophytes are spreading over large portions of terrestrial plant surfaces. Photoautotrophic organisms within these crusts sequester atmospheric CO_2 and many of them inhabit nitrogen-fixing cyanobacteria, utilizing atmospheric N_2 to form ammonium which can be readily used by vascular plants. In a thorough literature search, we compiled all available data on the physiological properties of cryptogamic covers and developed a model to calculate their annual nitrogen fixation and net primary production. In a detailed long-term study, the net primary production of biological soil crusts was analyzed.

In our modeling approach we obtained a total value of 3.9 Pg a^{-1} for the global net uptake of carbon by cryptogamic covers, which corresponds to approximately 7% of the estimated global net primary production of terrestrial vegetation. This value is of the same magnitude as the global annual carbon turnover due to biomass burning, which has been estimated at 3.6 Pg a^{-1}. Nitrogen assimilation of cryptogamic covers revealed a global estimate of ~49 Tg a^{-1}, accounting for as much as about half the estimated total terrestrial biological nitrogen fixation.

In our long-term study, the microclimatic conditions (water status, temperature, light intensity) of four different types of biological soil crusts have been monitored over one whole year. These data revealed that the crusts were active for a total duration of approximately 35 days during the year, experiencing mean temperatures of only 14.6°C in an active state. Microclimate data were combined with CO_2 gas exchange properties of the four crust types to obtain their annual net primary production. Calculation of the net primary production on a spatial scale was accomplished by a remote sensing approach. Based on hyperspectral remote sensing data an algorithm was developed to classify biological soil crusts of the Succulent Karoo. Knowing the fraction of each crust type, their long-term productivity could be analyzed at high accuracy.

O5 - Springs as source of information for regional scale climate change effects

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Effects of climate change on fluxes of energy and matter and thus on functioning of forest ecosystems has been studied intensely in local case studies and modelled at continental to global scales. However, processes at regional, landscape and ecosystem scales are hard to assess with conventional monitoring methods such as climate stations. In forest springs, fed by surface near water transport, solutes from the whole catchment are seeping out of the ground punctually. This enables spatial integrating and instantaneous monitoring of forest catchment processes. Furthermore, stenoecious spring vegetation, which is evolutionary adapted to the naturally constant spring habitats, reacts sensitively to various kinds of environmental shifts. Both facts emphasize the potential of helocrenic forest springs to monitor climate change effects in a comprehensive way.

The major objective of the AD FONTES research project is to develop a monitoring tool to assess and project climate change impacts on regional scale processes of forest ecosystems by using the ecological response of springs. Helocrenic forest springs are studied in the lower mountain range of north-eastern Bavaria since 1989. On-going examinations of physico-chemical water characteristics and small scale vegetation patterns are used to unravel biotic long- and short term response characteristics of these springs and their environmental drivers. As helocrenic springs occur in a high spatial density within the studied forested landscape, regional scale effects of climate change on forest ecosystems can be assessed with a high spatial resolution and transferred to comparable habitats on a much larger spatial scale. The results of this study will assist forestry and nature conservation authorities to develop regional scale management strategies to cope with the effects of ongoing global climate change.

P1 - Emissions of greenhouse gases in soil of Chilean old-growth temperate rain forest ecosystems

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Forest ecosystems influence climate and atmospheric composition through their overall large potential to trigger biogeochemical cycles, including those of CH_4, CO_2 and N_2O. One of the main threats to forests is deforestation, as it causes the deterioration of its environmental components, thus altering biogeochemical cycles. The hypothesis is that anthropogenic disturbances such as deforestation, produce accelerated decomposition of organic matter and cause a loss of ecosystems resilience by altering biogeochemical cycles, and increase emissions of greenhouse gases (CH_4, CO_2 and N_2O). This study aims to determine the environmental impact of deforestation in Old growth temperate rainforest in South Central Chile (40°S) and the resulting greenhouse gas- emissions from soil. The results indicate that CO_2 and N_2O fluxes were altered from deforestation, soil efflux of CO_2 decreased by 58%, while N_2O emissions increased by 97%. CO_2 and N_2O fluxes showed positive correlation with soil temperature. (Project Fondecyt 1110331).

Session 23 - Conservation genetics in practice: applications of genetics in active conservation management

Chairs: Gernot Segelbacher, Rolf Holderegger

O1 - Bringing genetic diversity to conservation policy and management

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Genetic tools are extensively used in the research fields of ecology and conservation leading to specialised disciplines like conservation genetics and landscape genetics. However, genetics is still often neglected by biodiversity managers and policy makers. This gap between the scientific community and conservationists is still apparent despite the fact that safeguarding genetic diversity is explicitly mentioned within the Aichi 2020 Target of the CBD (Target 13). We here summarise our results on the attitude and experiences of European conservation professionals based on questionnaires sent by the ConGRESS Framework 7 Support Action (www.congressgenetics.eu). We discuss the implications of these findings for academics involved in conservation genetics and suggest that a much closer partnership between academic conservation geneticists and conservation practitioners is necessary if the full potential of genetic tools in conservation is to be realised. A few case studies will highlight the potential of such an improved knowledge exchange.

O2 - Research questions in biodiversity conservation identified and prioritized by practitioners: Is conservation genetics (not) important?

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A gap between science and practice hinders the effectiveness of biodiversity conservation. Since scientific studies are often impractical for implementation, several surveys have sought research questions relevant to conservation practice. Prioritization of these questions has never been attempted although it would provide invaluable information for steering future research. We surveyed Swiss conservation practitioners to identify and prioritize their needs for useful scientific information. A selected subgroup generated a list of relevant research questions in an inductive survey, which was then submitted through an online platform to all registered conservation practitioners in Switzerland. They were asked to rate the importance of each question, to nominate missing questions and to specify "hot topics" relevant to their field. The results allowed the

identification of general and ecosystem-related research priorities which were integrated in a research agenda. Generally, questions concerning single-species ranked above ecosystem-related questions, and questions related to economic, societal and stakeholder conflicts were found to be more important than conceptual questions. Yet, while ranking adequately reflects research priorities, the selection and framing of the questions may have been affected by the knowledge and experience of the participants. Genetic aspects of biodiversity conservation for example were explicitly mentioned only once, although many high-ranked questions indirectly related to genetic processes or would require genetic methods to be answered. We conclude that research fields which are highly relevant for conservation but poorly advertised or explained by science may be underrated by practitioners. Better communication, along with decision support systems that guide practitioners through the process of defining analytical questions and interpreting their outcome, may highlight the potential of molecular tools and enhance their perceived importance.

O3 - Genetic studies to improve conservation management in Alpine ibex and other reintroduced populations

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Reintroduction is an important tool in conservation management and many species have been successfully reintroduced. However, founder events and bottlenecks associated with the reintroductions cause genetic drift leading to lost genetic variation and increased inbreeding. While lost genetic variation poses a risk in the long-term due to lost evolutionary potential, inbreeding with its well-known detrimental effects is a more immediate risk for reintroduced populations. Therefore, management actions to reduce inbreeding are central for conservation biology. This may be accomplished first by reducing inbreeding in established populations with appropriate management implications and second by planning reintroductions in such a way that accumulation of inbreeding is minimized. Here we investigate both issues using detailed information about the reintroduction history of 40 Swiss Alpine ibex populations together with genetic data from 37 microsatellite loci.

Genetic variation in Alpine ibex populations was low and inbreeding levels were high. Variation in genetic diversity and inbreeding among populations was mainly attributable to parameters of the founder history, such as the degree of admixture in the founder group and number of founder individuals. In addition, population growth after founding had an impact on levels of inbreeding. These results highlight the importance of the composition of the founder group and the early growth rate after founding in reducing inbreeding and genetic drift in reintroduced populations. Insights gained from this population genetic study have been used to inform conservation actions that have been implemented in some populations, and that form part of the revised recommendations on management implications for Alpine ibex by the Swiss Federal Office for the Environment (FOEN).

O4 - The effects of tree type and forest management on the genetic diversity of a forest-stenotopic ground beetle

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While the effect of land use management on species diversity is well studied, the effect on other levels of biodiversity, such as genetic diversity, remains poorly understood. We have collected 143 populations of the stenotopic, flightless ground beetle, *Abax parallelepipidus*, from the forest plots of the Biodiversity Exploratories, which represent the major forest management strategies and tree types found in central Europe. We developed a suite of 14 polymorphic microsatellite markers for this species and sequenced 24 individuals from each of these populations. The three Exploratories show differing levels of genetic differentiation and allelic richness, allowing us to explore how the local landscape history and parameters influence contemporary patterns. We analyze how the current biotic and abiotic factors, the current landscape connectivity measures, as well as a measure of past connectivity are related to genetic diversity and differentiation. This allows a deeper understanding of the drivers of genetic diversity, including the comparison of past and present forest fragmentation. These insights will allow the future development of management plans which account not only for species diversity, but also allow for greater conservation of genetic diversity.

O5 - Effectiveness of conservation management for a damselfly: an ecological, genetic, social and economic evaluation

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Coenagrion mercuriale is a damselfly, which is critically endangered in Switzerland and a target species of the Smaragd network of protected areas, the Swiss equivalent to Natura 2000. The largest Swiss populations of *C. mercuriale* occur at slow flowing streams and ditches in the Smaragd area Oberaargau, located in an intensively managed agricultural landscape. The regional Smaragd project implemented a series of conservation measures to increase habitat area, quality and connectivity for *C. mercuriale*. To measure the effectiveness of these actions, a multi-faceted evaluation took place. First, populations of *C. mercuriale* were monitored annually, showing that population sizes were stable or increasing. Several new populations did spontaneously form at distances of up to 1.2 km from known populations. Second, a genetic study focussed on connectivity and dispersal between populations. While closely-located populations were connected by regular dispersal along streams (≤ 1-2 km), dispersal between more distant populations occurred rarely but also across open agricultural land. Third, a campaign was initiated to inform residents of the Oberaargau about *C. mercuriale*. The effectiveness of this campaign was evaluated with questionnaires, which showed

that residents were aware of and valued *C. mercuriale*. Fourth, the summed costs to conserve *C. mercuriale* were determined. Annually returning costs for the regional communities were shown to be low, while initial investment costs were moderate. All these results indicate that conservation management of *C. mercuriale* in the Smaragd region Oberaargau is successful, both ecologically and socio-economically.

O6 - Comparison of population structure of *Buphthalmum salicifolium* in restored and natural habitats

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Calcareous grasslands are habitats with a very high conservation priority. They comprise a high number of species adapted to the specific conditions and are threatened mainly due to transformation to arable land. Therefore calcareous grasslands are frequently subject of restoration activities, involving the translocation of individuals in form of seed transfer.

In restoration, one major concern to achieve a successful long term establishment is that genetic diversity could decrease during the translocation process especially if it involves an ex-situ seed propagation step. Genetic diversity is considered as crucial for evolutionary response and adaptation to environmental conditions. Therefore, preservation of genetic diversity during translocation is one of the major factors that might influence success of restoration.

We investigate this context by analysis of microsatellite variation in multiple natural as well as restored populations of the yellow oxeye, *Buphthalmum salicifolium*, a rare species distributed on calcareous grasslands in southern Germany. Goal of the study is to investigate the development of genetic diversity in dependence of the restoration status of a population and in comparison to the source of material.

Microsatellite discovery using NGS resulted in about 30 polymorphic markers. So far a dataset of 20 populations is analyzed. Results so far show slight genetic structure between the Garchinger Heide as major source site and sites restored by hay transfer. We hypothesize that differences in source and recipient habitat constitute a selection filter that prevents the establishment of a part of the source genotypes. By investigating potential small scale genetic structure in the source population we aim to verify this hypothesis.

O7 - Conservation genetics in ex situ populations of the endangered *Silene otites* (Caryophyllaceae)

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The aim of botanic garden *ex situ* activities is to preserve plant samples that are representative of the extant *in situ* genetic diversity. In many botanic gardens, population size of *ex situ* collections is restricted, and cultivars are often affected by unconscious selection and adaptation to garden conditions. We investigated three different *ex situ* populations and their *in situ* source populations of the endangered dioecious plant species *Silene otites* after 20 - 36 years of isolation. Using AFLP markers, high levels of genetic differentiation (F_{st} = 0.21 – 0.36) between corresponding *in situ* and *ex situ* populations were found. Genetic diversity in the *ex situ* populations was lower than genetic diversity in the *in situ* populations. Bayesian clustering approach resulted in strong genetic differentiation between *in situ* and *ex situ* populations. Our results show that the *ex situ* populations investigated here failed the conservation requirements in a strict sense as they diverged genetically from their source populations and featured only a reduced genetic diversity. Small population sizes and unconscious selection during cultivation may be reasons for high genetic differentiation and loss of genetic diversity. Therefore, large effective population sizes and adequate sampling prior to *ex situ* cultivation are fundamental to preserve genetic diversity in cultivation. We also recommend near-natural *ex situ* cultivation with generation overlap and interspecific competition.

O8 - Conservation genetics and hybridization

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The convention on biodiversity aims at preventing the loss of all three levels of biodiversity: ecosystems, species and genetic diversity. Preserving genetic diversity of endangered species is ambitious as rare species often have a lower genetic diversity due to their smaller population sizes. *Ex situ* conservation strategies may even further decrease genetic diversity, if a small number of founder individuals have been integrated in the captive population or due to uneven reproduction within the captive population. We studied the genetic population structure of the European Wildcat and found significantly higher genetic diversity than in a wild population. However, this increase in genetic diversity could be attributed to hybridization with domestic cats. 71% of the captive Wildcats had a mitochondrial haplotype typical for domestic cats and at K = 2 nearly all Wildcats were assigned as domestic. Hybridization thus represents a severe threat to biodiversity and may even trigger misleading conclusions (increased genetic diversity). We observed a similar pattern during a recent invasion of non-native Wall Lizards in Germany, which hybridize with the native

lineage. The gene pool of the native lineage was rapidly displaced in some populations suggesting that the non-native lineage has a fitness advantage or that transgressive hybridization plays a role.

O9 - The relevance of time series in conservation genetics

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The genetic composition of populations are shaped by the interaction of contemporary and historical factors. Often, it is difficult to differentiate between historical and contemporary forces. However, the temporal analysis of populations using modern molecular techniques, allowing genetic analyses of historic material collected generations ago can resolve this conflation of modern and historical forces and provide an understanding of the forces driving the evolution of species. Such an approach enables the exploration of genetic structures and changes over long time spans and furthermore the identification of potential molecular imprints from population shifts. Hence, material from museum collections can play a vital role in the understanding and evaluation of recent population structures, especially if large numbers of individuals sampled at one site are available. Nevertheless, DNA which can be extracted from such historic samples is often a limiting factor due to degrading effects of chemical preservatives and unsuitable storage conditions. Many markers are sensitive to highly degraded DNA and cannot be scored reliably in many historical samples. Methods which rely on short DNA fragments (such as microsatellites or single nucleotide polymorphisms) are most suited for the analysis of long preserved and partially degraded samples. Recently developed genome reduction and Next Generation Sequencing techniques and their associated analysis pipelines offer additional opportunities to study such samples, yet these methods have not been tested for their consistency in historic samples. In this talk I will demonstrate that temporal comparative studies provide information on (i) shifts in species assemblages, (ii) the intraspecific effects of population fluctuations over time, and (iii) will highlight the effects due to habitat persistence *versus* habitat transformation – exemplified on vertebrate and invertebrate species.

P1 - Extending the theoretical basis of population genetics for partially asexual species

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Population genetics provides powerful tools for assessing the genetic diversity of populations, and may therefore be helpful for predicting their potential for adaptation and survival. As more and more studies make use of these tools, the demand for more sophisticated data analysis methods also increases. One particular problem is the applicability of classical population genetic theory to organisms which do not exclusively propagate by sexual reproduction, such as, e.g., many plants.

Frequently used methods in population genetics such as F-statistics rely on the Hardy-Weinberg equilibrium for providing a null model against which the field data is compared. However, deviations from Hardy-Weinberg may have multiple, interacting reasons which render all conclusions tentative. Based on a Markov chain model, we aim to provide expected values and distributions for common population genetic parameters as dependent on an average rate of asexual reproduction *c*. Thus, researchers and practitioners alike get their hands free to look at the effects of other influences.

By augmenting the theoretical background, we hope to broaden the range of organisms for which population genetic studies can complement purely ecology-based vulnerability assessments. On the other hand, better data analysis will aid us in understanding the contribution of genetic diversity to the maintenance of biodiversity at the species or ecosystem level.

P2 - Responses to intraspecific outbreeding within animal and plant species: a systematic meta-analysis

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When individuals from separate populations mate, the resulting hybrid offspring can experience fitness benefits (heterosis) or costs (outbreeding depression) relative to their parents. Understanding the distribution and extent of these genetic benefits and costs is essential for guiding conservation plans that seek to mix wildlife populations. We used systematic review and meta-analysis to synthesize outbreeding responses in natural populations of plant and animal species. Our dataset included 528 effect sizes, describing intrinsic outbreeding responses from 98 studies (involving 79 species). We found that outbreeding responses varied significantly with hybrid generation, and between life history and other traits. In addition, we found that outbreeding depression and heterosis could be predicted by combining information on population demography, environmental and cytogenetic contexts. Studies for which we predicted a risk of outbreeding depression showed a cost to fitness in the F2 generation, relative to mid-parent performance. In cases predicted to exhibit heterosis, we observed a corresponding fitness benefit relative to the mid-parent. We consider whether and how these results, and our approach to predicting outbreeding responses, might be useful in conservation practice.

P3 - Contemporary evolution, phenotypic plasticity or genetic fixation: Rates of evolution and adaptive processes in populations under novel selection regimes

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The aim of this project is to assess the importance of contemporary evolutionary processes influencing phenotypic plasticity or/and genetic fixation and to assess their importance for the adaptive capacity and persistence of plants under novel and multiple selection pressures. The extent and timing of contemporary evolution will be studied by using populations of five different plant species that are managed as ex-situ collections in botanical gardens (BG) hence forming a study system that allows a precise determination of phenotypic and genetic changes due to a consistent change in selection regime. We compare 15 founder populations (cultivated for several generations in BGs) exposed to novel selection pressures for a defined amount of time with their original source populations in the wild. We will analyse 1) genetic diversity of BG and wild source populations by using restriction site-associated DNA tags (RAD tags) generated by high-throughput sequencing and 2) assess phenotypic diversity by comparison of life-history traits. To compare fitness parameters under changing conditions und multiple stress factors, all populations are reciprocally transplanted to all wild and garden sites. The same half-sib families are experimentally exposed to perturbations, i.e. to new environmental conditions. Thereby, the amount and interrelationship of local adaptation, phenotypic plasticity and genetic diversity in relation to the time since exposure to novel environmental conditions can be evaluated.

P4 - Reproductive isolation between sympatric cryptic lineages in the common wetland plant *Juncus effusus*

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The accumulation of ecological divergence between groups of individuals leading eventually to lineage diversification and the formation of new species is facilitated by reproductive isolation reducing effective gene flow. Molecular investigations revealing lineages that are reproductively isolated but are morphologically more or less indistinguishable and hence are called ‘cryptic’, have

become frequent in some taxonomic groups such as animals, but are surprisingly rare in others, as for example in higher plants.

Here we report a case of two sympatric cryptic lineages in the common wetland angiosperm *Juncus effusus* and ask whether gene flow by putative hybridization and introgression between lineages and with the closely related *J. conglomeratus* is able to counteract ecological mechanisms favoring reproductive isolation.

Our results show that *Juncus effusus* in Europe is composed of two genetically well differentiated lineages (*eff1* and *eff2*) differing not only at nuclear but also at chloroplast marker level. All molecular identified groups are found to differ significantly also in a number of morphological traits. However, a distinction between the two lineages of *J. effusus* based on morphology only is hardly possible and therefore it can be justified to speak of ‘cryptic’ lineages. We could demonstrate a strong differentiation in the date of first flowering among all lineages, with *J. conglomeratus* flowering first, followed by individuals of *J. effusus eff1* and later by *J. effusus eff2*. Flowering time could be an important response trait to selective pressures by pre-dispersal seed predators, as the early flowering lineages suffered similarly strong from seed predation, whereas the later flowering *J. effusus eff2* was significantly less affected.

We found evidence for hybridization between all studied lineages, mostly between *J. effusus* group *eff1* and *J. conglomeratus*. Hybrids are fertile and thus might be able to backcross with parental populations but differences in flowering time as well as the high degree of self-fertilisation are likely to reduce effective gene flow between lineages.

P5 - Epigenetic variation in a genetically depauperate range-expanding species

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Range-expanding or invasive species that lack genetic variation present an evolutionary paradox as genetic variation is a commonly assumed precondition for success in novel environments. However, epi-genetic variation, e.g. DNA-methylation may represent a mechanism to confer variability of gene-expression and thus phenotype similar to that generated by allelic variation at DNA level.

We investigated levels and patterns of DNA-methylation in the selfing annual herb *Ceratocapnos claviculata,* which has previously been shown to be strongly genetically depauperate, consisting of only 2 major genotypes across large parts of its native and expanding range. A total of 153 individuals in 39 populations were analysed using MSAP (methylation sensitive amplification polymorphism)
Epigenetic variation (182 polymorphic loci) was much higher than genetic variation at AFLP loci (40 polymorphic loci). In contrast to genetic variation, epigenetic variation did not decline towards

North or East and was not lower in the expanding range. Bayesian analysis of populations structure and PCO analysis revealed the existence of two gene pools, which however, did not clearly correspond to geographic regions or site conditions.

The existence of considerable epigenetic variation across the range of the species independent of the level of genetic variation is consistent with a functional role that contributes to phenotypic plasticity in this range expanding species. The lack of strong epigenetic variation and obvious lack of bottleneck effects suggests that epigenetic variation at least partly is generated de novo. From a conservation genetic viewpoint it may be hypothesized that epigenetic variation represents a mechanism conferring phenotypic plasticity even at low levels of genetic variation typically found in rare species.

Session 24 - Functional diversity of vegetation: Linking modeling and empiricism

Chairs: Anja Rammig, Alice Boit, Kristin Bohn, Jens Kattge

O1 - The potential (and limitations) of global plant trait databases: Lessons from TRY

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Plant traits determine how primary producers respond to environmental factors, affect other trophic levels, influence ecosystem processes and services, and provide a link from species richness to ecosystem functional diversity. Plant traits thus are a key to understand the functional diversity of vegetation and predict the adaptation of ecosystems to environmental changes. At the same time plant trait data are dispersed over a wide range of databases, many of these not publicly available. To overcome this deficiency we have developed a worldwide communal plant trait database, called TRY. Its goal is the construction of a standard resource of plant trait data for the ecological community and for the development of global vegetation models, while at the same time respecting intellectual data property. With this approach, TRY is a novel undertaking from both the scientific and sociological points of view.

So far the TRY initiative has united a wide range of the plant trait research community worldwide and gained an unprecedented buy-in of trait data. A first analysis of the database shows that simple a-priori plant functional types (PFTs), as commonly used in vegetation models, capture a relevant fraction of the observed variation - but for several traits up to 70% of variation occurs within PFTs. Due to its origin from several independent databases the joint dataset is still a sparse data matrix. This sparsity might be overcome using advanced methods currently being developed in applied statistics and machine learning. On the long term the improved availability of plant trait data in the unified global database is expected to support a paradigm shift from species to trait- and trait syndrome-based ecology, offer new opportunities for synthetic plant trait research and enable a more realistic and empirically grounded representation of the functional diversity of vegetation in Earth system models.

O2 - Functional diversity and productivity of tropical rainforest

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Tropical forests are not only a hotspot of biodiversity, they also store a quarter of the global terrestrial carbon. Experimental studies from temperate grasslands indicate that biodiversity may enhance vegetation productivity because species are complementary in resource use and that, in line with the biomass ratio hypothesis, community-weighted mean (CWM) trait values predict productivity. Yet, it is not clear whether this also applies for highly diverse, natural tropical forest systems.

Here we present results from four tropical forests in Bolivia, Brazil, and Costa Rica. We focused on community functional properties, rather than taxonomic diversity, as this should be directly related to ecosystem functioning. We measured eight productivity-related traits for the most dominant tree species, and calculated CWM trait values and aboveground biomass stocks and productivity for 72 1-ha forest plots with individuals >= 10 cm dbh, using allometric equations.

We found that tropical forest stands with “fast”, productive leaves that capture a lot of light (high leaf area per unit leaf mass) and have a high photosynthetic capacity (high leaf nitrogen concentration) have high biomass growth rates. This fast lifestyle comes probably along with a high turnover rate, and hence results in low standing biomass stocks. Therefore, in highly diverse natural tropical forest systems community functional properties do matter for ecosystem functioning. These results show how a functional approach to tropical forest productivity studies can increase understanding of ecosystem processes and strengthen the scientific basis of management for carbon fixation and storage.

O3 - Trait convergence and divergence in North American trees along a species richness gradient

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The relationship between species richness and the occupation of trait (= niche?) space can provide insights into the processes that shape patterns of biodiversity. For example, species interactions may lead to an even spacing of species within trait space (i.e. trait divergence), because of limits in similarity and resource partitioning, whereas, environmental filters may lead to an uneven or clumped spacing and a functional convergence of species into functional groups. Here, we explore the role of these two processes along a continental-scale species richness gradient.

We examine trait space occupation patterns of tree communities over continental North America using distribution maps of 250 North American tree species in combination with 23 functional traits. Specifically, we (1) examine the relationship between species richness and functional diversity, (2) contrast this relationship with a null model assuming random trait space occupation, (3) uncover trait syndromes causing even vs. uneven trait space occupation.

We find that the dispersion of species within trait space increases rapidly from low to intermediate species richness levels and decreases slowly towards high richness levels. The peak at intermediate richness levels is geographically located in the transition zone between the boreal and the temperate region where gymnosperms and angiosperms coexist in mixed evergreen-deciduous forests. We can attribute the decrease in functional dispersion towards high species richness to a functional convergence of species in their leaf and demography traits, whereas considering wood and biochemical traits, species disperse rather random and more even in the trait space.

These results reveal that functional convergence and divergence can operate simultaneously depending on the traits conveying the different aspect of plant functioning. Pursuing the question of why this is the case may have far reaching implications, not only for the formulation of trade-offs in vegetation models generating functional diversity, but also for the identification of processes that allow stable coexistence in hyper-diverse communities.

O4 - Connecting dynamic vegetation models to data - an inverse perspective

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I will talk about different aspects around the issue of connecting process-based vegetation models to (trait) data. A basic distinction that I will discuss is that model parameters and structure can be estimated directly (e.g. with dedicated experiments/observations) or inversely (by comparing model predictions with observed data). The latter method, inverse calibration, has experienced a recent boost in interest and applications, connected to the fact that computational advances allow running sophisticated calibration algorithms such as MCMCs that were previously inaccessible. Despite this progress, however, inverse calibration always runs the risk of “getting the right answer for the wrong reason”. I therefore argue that a combination of direct and inverse calibration in a statistical (Bayesian) framework offers the most flexible and complete answer to the model-data problem. I will present some examples of Bayesian calibrations and discuss two further aspects, the issue of using data measured at different scales, and a more recent class of simulation-based inference methods that allow extending Bayesian statistics to complex stochastic model structures.

O5 - The role of biodiversity for the carbon cycle: Implementation of functional diversity in a dynamic vegetation model

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Most dynamic global vegetation models (DGVMs) condense natural plant diversity to plant functional types (PFTs). A single PFT usually represents a whole biome, e.g. the PFT “tropical broadleaved evergreen tree” and its constant set of functional trait parameters covers entire regions in the model. This approach minimizes functional diversity and neglects the effects of functional diversity on the modeled vegetation and carbon dynamics. Our work aims to overcome this limitation and extend functional diversity in the vegetation model LPJmL to explore the role of biodiversity in climate change mitigation. Our approach improves the representation of biodiversity in the model by incorporating the natural ranges and eco-physiological interrelations of relevant plant traits. Empirical data on plant traits is provided by the TRY data base (www.try-db.org) and the ROBIN project (www.robinproject.info). A first sensitivity analysis revealed that simulated carbon stocks are very stable under a large range of trait combinations. However, several model output variables appeared highly sensitive to small changes of plant trait parameters and thus the introduction of trait ranges requires several improvements of the PFT concept of LPJmL. One possible way of improvement is to implement missing plant-trait trade-offs, which will be used to simulate the growth of individual plants with flexible parameter combinations at the landscape scale. Our improved model will enable for the simulation of local competition and complementarity of individual plants which, according to their trait values and ranges, can then be categorized into a much broader variety of PFTs. This modeling approach will allow for investigating the role of bio- and functional diversity in the global carbon cycle as well as in regional vegetation dynamics.

O6 - Successional over- & underyielding in functionally diverse forests due to efficient light use and delayed establishment

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Biodiversity experiments revealed positive relationships between biodiversity and ecosystem functioning. Both diversity and functioning are known to change during plant community succession but their mechanistic interactions, especially in forests, have rarely been studied. Ecosystem functions of primary concern are ecosystem productivity and storage of carbon.

We ask the following questions: 1) How does the biodiversity-productivity relationship develop in the course of forest succession? 2) What are the mechanics underlying this relationship?

We address the questions by means of experiments using a trait-based vegetation model (LPJ–GUESS). On a species level, the model requires 27 functional traits as parameters. We extracted a functional trade-off with empirical data on these functional traits of 31 deciduous and broad-leaved tree species. From along this trade-off, we derived a set of pseudo species, which represent a simplified strategy scheme. These pseudo-species were used in trait-based extinction scenarios, which cover a gradient of initial functional richness and functional identity. Null-model expectations were derived from monoculture yields.

We obtained the following answers to the questions: 1) Functional diversity always declined in the course of succession and functional identity conversely always shifted into the direction of the most competitive species. The trajectory and final levels of biomass were very much related to identities of available species. Overyielding occurred in early and diverse phases, followed by successional underyielding and in later and less diverse phases there was no difference to monocultures. 2) Positive effects of functional diversity on productivity were related to complementary light use and reduced mortality. Negative effects were related to a successional delay of better performing species.

O7 - Simulating climate change impacts on functional diversity: the trait-based dynamic vegetation model aDGVM2

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Dynamic global vegetation models are a powerful tool to project the past, current and future distribution of vegetation and associated water and carbon fluxes. However, most models are limited by how they define vegetation and by their simplistic representation of competition. We show how concepts from community assembly theory and coexistence theory can help to improve vegetation models. We further present a new trait- and individual-based dynamic vegetation model (the aDGVM2) that allows each individual plant to adopt a unique combination of trait values. These traits define how each individual plant grows and competes with other plants under given environmental conditions. The performance of individual plants in turn drives the assembly of a plant community. A genetic optimisation algorithm is used to simulate the inheritance of traits and different levels of reproductive isolation between individuals. Together these model properties

allow the assembly of plant communities that are well adapted to a site's biotic and abiotic conditions. We illustrate that the aDGVM2 can simulate responses of assembled trait spectra, carbon allocation patterns, phenological strategies and functional diversity along environmental gradients. We further show that the model allows novel insights as to how vegetation responds to climate change and disturbances. The aDGVM2 deals with functional diversity and competition fundamentally differently from current dynamic vegetation models and we believe that it could foster fruitful collaborations between research communities that focus on plant functional traits, plant competition, plant physiology, systems ecology and earth system science.

P1 - Leaf acarodomatia of *Viburnum tinus*

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Domatia are small invaginations and hair tufts usually found at vein junctions on the undersides of leaves in many woody dicotyledon plants. Different types of leaf domatia exist, they are found in more than 2000 plant species of several families. They are frequently occupied by predatory and mycophagous mites, sometimes at very high densities. Mites utilize domatia as shelter against adverse conditions or against other predators and cannibals. Plants may benefit from the presence of the mites through reduced densities of herbivores or plant-pathogenic fungi. Thus, domatia mediate a mutualistic interaction between plants and mites. In the present contribution, we analyze the role of acarodomatia on *Viburnum tinus*, a Mediterranean plant which can be employed as banker plant to improve biological pest management in crop production in the Mediterranean region. As shown in experiments, predatory mites, e.g. *Amblyseius californicus*, install and reproduce efficiently on *V. tinus* and reduce the numbers of pest mites, e.g. the red spider mite *Tetranychus urticae*. We analyze the availability of domatia on the plant depending on the developmental stage of the leaves, their exposure to sunlight, and differences in physiognomy of plants. We test whether number and size of domatia is constant along the annual cycle, and which role potential changes may play for the development of predatory and pest mites.

P2 - Combining an individual-based and a statistical model to study the resilience of coastal marshlands under climate and land use change

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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 the ecosystem service (ESS) provision by the coastal vegetation at the German North and Baltic sea coast. We model how disturbance events like salt water intrusion and fresh water flooding affect the composition of plant communities and hence ESS provision. We classify plant species into plant functional groups on the basis of their effect and response traits. Plot-level data on species distribution, plant and ecosystem traits as well as environmental conditions is used to estimate statistical species distribution models (SDM). These models predict the habitat suitability, i.e. occurrence probability of single plant species or plant functional types and will be used to upscale from the plot to the regional scale. The shortcoming of SDMs is that they only result in the potential distribution of a species. They do not simulate temporal sequences of events (i.e. their results are independent of earlier events), nor do they take dispersal limitation into account. Therefore, we also use the collected data to parameterize an individual-based model (IBM) that simulates small scale resource competition applying a zone-of-influence approach. This model will include dispersal from seed sources as well as the reaction of plant individuals to salt and water stress. This IBM is able to model the reaction of plant functional types to disturbance events with high temporal and spatial resolution. The level of process detail, however, limits the application of this model on the landscape scale through computation time. Thus, we plan to couple both approaches to overcome each model’s weakness.

P3 - Interactions between structural diversity and vegetation functions -- short rotation coppice strips in agricultural landscapes

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Energy cropping with perennial crops like energy trees provides habitat qualities with some similarities to extensive land management. The multiannual soil rest, the lack of fertilization, pesticide use are expected to evoke positive effects on soil dynamics and wildlife. Short rotation crops especially when grown in strips are habitats characterized by a high structural diversity and successional dynamics. To investigate what the high structural dynamics implies for the landscape context, where the SRC were established in, was subject of the Research Framework ELKE (*Establishing extensive land use systems as compensation measures).* We investigated the potential of SRC strips to contribute to both the sustainable use of biomass and nature-conservation targets. The major objective of this project was to identify the biodiversity effects of SRCs within the context of a given landscape. Our field studies, which were carried out on the Research Farm at Scheyern (Bavaria) between 2011 and 2012, focused on comparing the structural diversity within three different SRC-crops with those of a variety of regional reference biotopes. We found SRC strips as having the highest structural diversity compared to arable fields, meadows, fallows, field margins, forest edges and forest habitats. Parallel to this, species richness and the provision of flowering plants were highest in the SRC´s too. SRC strips showed a species composition characterized by a mix of species from arable land, meadows and field margins but also with a high number of singular species. The structural diversity showed high variance depending on tree crop species and planting age. We have analyzed the relationship between the structural diversity of the SRC strips and a number of key functional parameters and the composition of the ground vegetation in order to identify management options for improving biodiversity effects of the SRC´s. The conclusions for the implementation of biodiversity friendly cropping techniques are discussed.

Session 25 - Microorganisms in Biodiversity - Ecosystem Functioning Research

Chairs: Nico Eisenhauer, Kirsten Küsel

O1 - Microbial communities as a tool to investigate ecological theory

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Ecological models are often tedious to validate in the field due to the large number of samples required for testing complex hypotheses. Here I will discuss the use of microorganisms as model organisms in ecological research. Many microorganisms, including bacteria, protozoa and yeasts, grow fast and can be used in high throughput laboratory experiments. I will present how such experiments can be used for testing hypotheses related to biodiversity-ecosystem functioning relationships, invasibility or resilience to environmental perturbations. I will further discuss how combinations of computer simulations, genomic data mining and laboratory experiments may contribute to our mechanistic understanding of the relationship between biodiversity and ecosystem functioning.

O2 - Microbial model systems and microbial interactions in BEF research

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The majority of biodiversity-ecosystem function (BEF) experiments have focused so far on primary producers. Despite the importance of microbial communities for different ecosystem processes, biodiversity effects are much less understood in microbial communities. Only a few studies have manipulated for instance bacterial richness to reveal bacterial BEF relationships.

Moreover, it remains uncertain how microbial interactions within and across trophic levels (e.g. competition, complementarity, mutualistic interactions, prey-predator interactions) modify the mechanisms responsible for biodiversity effects along richness gradients. It is also so far unknown how species diversity determines the reaction of microbial communities to environmental changes like those predicted to take place in the future.

Microbial model systems are in particular promising due to their simplicity, the high degree of control and easy experimental replication to answer questions with respect to BEF and beyond that. Studies performed with model systems will be presented with a focus on the impact of negative bacterial interactions or prey-predator relationships on bacterial diversity effects, the shift of competitive species interactions to mutualistic ones in response to increasing environmental stress, and the role of the interactions type in buffering environmental changes. Including the “interaction context” in microbial BEF research is a key to understanding, managing and predicting microbial ecosystem processes. Such level of manipulation can be achieved best in microbial model systems, which are promising tools for fundamental hypothesis-driven experiments in general and microbial ecology.

O3 - Linking functional microbial diversity to carbon and nitrogen cycling in aquifers

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Microbial processes in aquifers play a crucial role in the provision of clean drinking water. The extent of these ecosystem services can be strongly affected by the diversity of the involved microbial communities. Here, we investigated the composition of bacterial and archaeal communities involved in carbon fixation and nitrogen transformations in the groundwater of a shallow, suboxic, and a deep, oxygen-rich limestone aquifer in the Hainich region (Thuringia, Germany). The objectives of this study were (i) to detect microbial key players linking carbon fixation to the cycling of nitrogen or sulphur based on functional gene markers, (ii) to follow seasonal patterns in the abundance of these groups, and (iii) to link activity measurements of CO_2-fixation, nitrification and denitrification to the estimated genetic potential for the corresponding processes. Results of quantitative PCR suggested that approximately 0.3 to 14 % of the groundwater bacterial population had the genetic potential to fix CO_2 via the Calvin Cycle. Pyrosequencing and clone library analysis of *cbbM* and *cbbL* transcripts encoding RubisCO type I and II pointed to a rather low diversity of CO_2-fixing bacteria including *Sulfuricella denitrificans*- and *Nitrosomonas ureae*-related microorganisms, which was confirmed by the analysis of genes encoding ammonia mono-oxygenase, and nitrite reductase. Moreover, putatively autotrophic ammonia-oxidizing archaea constituted a large fraction of the archaeal population. Our results provide strong evidence that chemolithoautotrophy coupled to nitrification by bacteria and archaea contributes to the carbon flow at high oxygen availability. In contrast, carbon fixation appears to be primarily linked to other metabolisms involving sulphur and iron coupled to denitrification under low oxygen availability. Thus, the aquifer harbours the potential to transform nitrogen compounds originating from agriculture to gaseous forms not affecting drinking water quality.

O4 - Spatial and temporal variation of the fungal metagenome away from tree trunks in temperate forest ecosystems

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Fungi show high functional diversity in soil environments. They appear as symbionts, pathogens, or saprobes and affect the structures and dynamics of plant communities. However, little is known about the relationship between soil fungi and forest tree species and the spatial and temporal distribution of fungal communities away from tree trunks and soil depth.

We are currently studying soil fungal communities on a spruce (*Picea abies* L.) and a beech (*Fagus sylvatica* L.) forest plot of the Hainich-Dün Exploratory (Thuringia, Germany) to fill this knowledge gap. The study plots are part of a large interdisciplinary research consortium funded by the German Science Foundation (DFG) called the *German Biodiversity Exploratories*. Soil cores of two soil layers (0-10 cm, 10-20 cm) were sampled at a distance of 0.5 m, 1.5 m, 2.5 m, and 3.5 m away from the tree trunk from four individual trees species per plot. To evaluate seasonal dynamics, the sampling was done in May and November 2012. The fungal community was assessed using a high-throughput amplicon pyrosequencing approach amplifying the internal transcribed spacer (ITS) region of the ribosomal DNA as a marker.

We hypothesized that the fungal community compositions are affected not only by soil abiotic factors but also by the host plant species. Further we expect to see spatial and temporal changes in the fungal community composition. We will present the impact of host tree species, distance from the trunk, and soil depth on the fungal community composition and their ecological implications will be discussed.

O5 - Arbuscular mycorrhiza fungal diversity and community structure along land use gradients in Germany's grassland ecosystems

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Fungi are of central importance within the plant-soil system as illustrated by mycorrhizal interaction between fungi and roots, which enable a direct exchange of soil minerals against photoassimilates. The oldest type of this symbiosis is the arbuscular mycorrhiza (AM) formed between approximately 80% of todays land plants and the fungal phylum Glomeromycota.

In grasslands ecosystems land use regime influences the species composition of both plants and soil microorganisms, but only recently, the development of high-throughput molecular tools enables us to precisely enlighten the relationship between land use regimes and AM fungal diversity. The interdisciplinary joint project "Biodiversity Exploratories" investigates an extensive set of grassland plots under variable land use regimes for which numerous baseline ecological data (e.g. pH, plant species composition, etc.) are available. We studied the impact of land use type on the AM fungal diversity and community structure along plots of the three exploratories by using 454 sequencing of target regions in the rDNA.

Based on separation of operational taxonomical units (OTUs), we show a high species richness of AM fungi in all exploratories. In the presentation, the respective effects of land use intensity, geographic conditions and soil parameters on AM fungal community structure will be disentangled.

O6 - Species richness of arbuscular mycorrhizal fungi: associations with grassland plant richness and biomass

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The species richness of arbuscular mycorrhizal fungi (AMF) increases with aboveground plant richness and biomass in experiments, but this has not been studied in natural ecosystems. Moreover, virtually nothing is known about how AMF richness associates with belowground plant richness and mass. We examined relationships among AMF species richness, and above- and belowground plant richness and biomass in a native North American grassland. AMF richness and belowground plant richness were measured with 454 pyrosequencing, using fungal SSU rRNA and plant trnL gene sequences. We detected 70 AMF taxa, which is among the highest levels of AMF richness recorded in a natural plant community site of comparable size. AMF richness was positively correlated with plant species richness above- and belowground. Belowground plant richness was positively correlated with belowground plant mass and total plant mass. In contrast, aboveground plant richness was not correlated with any aspect of plant mass. Contrary to our expectations, AMF richness was negatively correlated with belowground and total plant mass. Our results from natural vegetation are the first to confirm the findings of experimental studies showing the positive association between AMF and plant richness levels. In contrast, we did not find evidence of a positive relationship between AMF and plant productivity, nor did we confirm a negative relationship between plant richness and plant productivity belowground, a relationship previously described for aboveground. By sequencing bulk root samples from a natural system we were able to gain new information on the relationships among belowground plant richness, the richness of their associated fungi, and plant productivity as important factors of ecosystem function.

O7 - How plant diversity increases soil carbon storage

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Soils are one of the most important carbon sink and sources. Soils contain up to 3/4 of all terrestrial carbon. Beside physical aspects of soil properties (e.g. soil moisture and texture) plants play an important role in carbon sequestration. The positive effect of plant diversity on carbon storage is already known, though the underlying mechanisms remain still unclear. In the frame of the Jena Experiment, a long term biodiversity experiment, we are able to identify these processes. Nine years after an land use change from an arable field to managed grassland the mean soil carbon concentrations increased towards the concentrations of permanent meadows. The increase was positively linked to a plant diversity gradient.

High diverse plant communities produce more biomass, which in turn results in higher amounts of litter inputs. The plant litter is transferred to the soil organic matter by the soil microbial community. However, higher plant diversity also causes changes in microclimatic condition. For instance, more diverse plant communities have a more dense vegetation structure, which reduced the evaporation of soils surface and thus, increases soil moisture in the top layer. Higher inputs and higher soil moisture lead to an enlarged respiration of the soil microbial community. Most interestingly, the carbon storage in the Jena Experiment was much more related to microbial respiration than to plant root inputs. Moreover, using radiocarbon, we found a significant younger carbon age in soils of more diverse plant communities than in soils of lower diversity, indicating that more fresh carbon is integrated into the carbon pool. Putting these findings together, we could show, that the positive link between plant diversity and carbon storage is due to a higher microbial decomposition of plant litter, pointing out that carbon storage in soils is a function of the microbial community.

O8 - Different microbial groups contribute differentially to carbon cycling in soils

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Microbial communities in soils are a key factor controlling decomposition processes and accumulation of soil organic matter. The microbial activity in soils is driven by plant biomass; microbes transform plant litter (roots and shoots) as they use it as a source of nutrients and energy and at the same time they make nutrients available for plant growth. In the present work we wanted to determine whether there are differences among microbial groups' contribution to soil organic carbon storage; and if those potential differences are influenced by plant diversity. To that end, we traced the $\delta^{13}C$ in different soil microbial groups (bacteria, fungi) from a plant biodiversity experiment with two diversity levels: 4 and 16 species, after 4 weeks of continuous labelling with $\delta^{13}CO_2$. Abundance, structure and $\delta^{13}C$ labelling of the microbial community were investigated at two different soil depths (0-5 cm and 5-10 cm), using phospholipid fatty acids and neutral lipid fatty acids (PLFAs and NLFA). PLFAs were used as biomarkers for bacteria and saprophytic fungi; and NLFA was used to identify arbuscular mycorrhizal fungi (AMF). We found a significantly higher total.amount of PLFA and NLFA in the topsoil; this could be due to higher resource availability in the rhizosphere. The total amount of PLFA did not change among diversity levels, whereas the NLFA was significantly higher in the more diverse plant communities. Further, we found higher $\delta^{13}C$ enrichment in the AMF than in bacteria and saprophytic fungi, which points to different use of carbon among different microbial groups. Probably, the AMF uses preferentially new carbon sources, whereas bacteria and saprophytic fungi are feeding from old sources of carbon.

O9 - Diet-related effects on the bacterial assemblages in the alimentary tracts of lady beetles

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Lady beetles host a rather simple community of residential endosymbionts in their alimentary tracts. The majority of bacteria recovered from their guts are likely transient organisms ingested with their food. As a consequence, the gut bacterial assemblage of lady beetles may serve as an indicator of their diet, and by extension, of food availability or selection within a local habitat. The broad food range and non-selective predation strategy of lady beetles makes it likely that their dietary diversity increases with resource diversity. We hypothesize that high food diversity will be reflected by a higher variability of the bacterial assemblage in lady beetle guts.

In this study, Lady beetles of six common species were collected in July 2012 in eight soy bean fields and eight prairies in southern Wisconsin. These habitats were selected to represent a contrasting diversity of plants and associated prey for ladybeetles. For each beetle, the complete alimentary tract was dissected out, and the community fingerprint of gut bacteria was evaluated by automated ribosomal intergenic spacer analysis (ARISA).

We found that the bacterial community profiles from beetles were largely governed by the identity of beetle species rather than the habitat where beetles were collected. These patterns were the result of different dominant bacterial taxa in particular species. However, species-specific differences in the variability of bacterial profiles may also be explained by diet differences between beetles. A laboratory feeding assay supports the hypothesis that the diet of lady beetles alters the bacterial assemblage in their alimentary tracts.

O10 - C:N:P stoichiometry of the soil microbial biomass in a grazed grassland site under experimental P manipulation

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On a global-scale, the C:N:P ratio of soil and the soil microbial biomass tend to be constrained, with the suggestion that differences in soil microbial biomass element ratios could provide an insight into microbial and plant nutrient limitations and feedbacks on soil organic matter accumulation in terrestrial ecosystems. Given the changing inputs of inorganic nutrients to many grassland soils we wanted to determine whether the stoichiometry of the soil microbial biomass and soil organic matter content could be affected by an unbalanced nutrient supply and if we could experimentally show nutrient limitation of the soil microbial biomass. We sampled plots from a long term grazing trial instigated in 1968 in which phosphorus has been applied annually at 0 (P0), 15 (P15) and 30 (P30) kg ha-1, with a split in 1999 to reduce P applications to the high-P plots and increase P to the low-P plots. Increasing fertiliser P increased microbial biomass C, N and P, and the C:P ratio but did not significantly affect the biomass C:N ratio. Substrate induced respiration indicated differential nutrient co-limitations, with the 0 P treatment having the smallest slopes and respiratory quotient. Multivariate analysis grouped the treatments as: [0-0]; [15-15/15-5]; [0-30/30-0]; [30-30]. Relative changes in microbial biomass C:P were under tight homeostatic regulation and indicative of nutrient limitation within a site, while the soil C:P ratio was a critical determinant of soil organic matter content via feed-backs on plant productivity and decomposition.

O11 - Microbial community structures and functions are resilient in metal pollution gradients as revealed by Illumina Sequencing and Microarray-Based Assessment

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To investigate the impact of long-term responses of soil microbial community composition, diversity, structure and metabolic potential to heavy metals pollution and environmental factors, soil samples were taken from 12 monitoring sites at two distinct gradients of metal pollution in Southern Poland, and analyzed using a Miseq illumina sequencing, Functional Gene Array (Geochip 4.2). The relative abundances of bacterial groups at different taxonomic levels correlated with soil pH, Na, Ca and Mn

content, but no significant relationships to Toxicity Index (TI) were found when all soil properties were used in Canonical Correspondence Analysis (CCA). However clear separation between soil bacterial community composition were observed when only toxic metal concentration (as an explanatory factor) were used in CCA model. We could not find any clear patterns in overall potential functional structure in relation to pollution level when all detected genes were analyzed with Detrended Correspondence Analysis (DCA), while distinct variations in metal resistance genes were detected. TI showed a significant effect on the metal resistance gene group among all functional genes only when CCA analysis was performed for each gene family separately. in Contrast to our hypotheses, long-term exposure to toxic metals (TI) were not the primary factor driving soil microbial communities, when all detected genes were used, while the nutrient contents were the key forces in shaping the community structure.

Keywords: illumina sequencing, GeoChip, Heavy Metals, Soil Microbial Communities

Session 26 - Environmental change and nature conservation

Chairs: Bruno Baur, Martin Dieterich, Thomas Fartmann

O1 Landscape heterogeneity affects the functional diversity of grassland Lepidoptera

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Biodiversity in agroecosystems is affected by human management practices at both the local and at the landscape-levels (e.g., reduction of landscape heterogeneity via homogenisation of land-uses). While local land use intensity is easier to measure in terms of fertiliser and pesticide application, grazing and mowing, landscape heterogeneity metrics are more difficult to obtain and are still at an early stage of development. To date, landscape heterogeneity has most-commonly been defined as the diversity of *human land uses* within a landscape (structural heterogeneity) and not in terms of habitat- or resource-requirements of animals (functional heterogeneity). While some species require quite specific resources or specific combinations of resources for different life-stages, others are freed from such ecological constraints and can readily utilise a wide range of habitats. Thus, by considering land uses in terms of the functional value that they represent for species (and not simply from a human land use perspective) we can expect to have a more accurate understanding of effects of landscape heterogeneity on species, functional groups and communities.

We examined the effects of landscape heterogeneity on community composition for Lepidoptera collected in the German Biodiversity Exploratories project. Further, we analysed the effects of landscape heterogeneity on the diversity of functional groups defined by traits representing habitat- and feeding-specialisation and dispersal ability. We report on how these different metrics of landscape heterogeneity relate to the functional diversity within the community. For example, preliminary results indicate that landscapes with decreased levels of structural heterogeneity select against smaller, less agile lepidopteran species. These findings may guide management practices for conservation of lepidopteran functional diversity in managed grasslands.

O2 - Land sparing or land sharing: Are these real alternatives for European agricultural landscapes?

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In recent years there has been a lively debate on whether biodiversity conservation and agricultural production could be better reconciled by land sparing (strictly separating production fields and conservation areas) or by land sharing (combining both, agricultural production and biodiversity conservation on the same land). Google scholar yields 37,600 hits when queried for "land sparing land sharing" (01.05.2013).

The debate originates from tropical countries, where agricultural land use continues to increase at the expense of natural ecosystems. But is it also relevant for Europe, where agriculture is withdrawing from marginal regions whilst farming of fertile lands continues to be intensified? We will explore whether land sparing or land sharing are real alternatives in the European context by examining the underlying assumptions and confronting them to recent findings of European research projects and case studies. Special attention will be paid to the issues of scale (field – farm – landscape) and ecosystem services.

We conclude that both approaches are needed for Europe. In productive regions, we recommend to promote land sparing at the field scale, but not at the farm and landscape scale. We advocate that farms and agricultural landscapes should (ideally) consist of both productive fields and semi-natural habitats. Semi-natural habitats close to productive fields yield ecosystem services and facilitate species to migrate through the agricultural matrix. In marginal regions, high-nature value farming is a traditional way of land sharing, yielding high quality agricultural products and conserving specialized species. Finally, at the landscape scale, there is a need for nature reserves to conserve highly disturbance-sensitive species.

O3 - Where does phytodiversity in agricultural vs. semi natural Central European landscapes come from?

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The pattern of human mediated disturbances dictates biodiversity in the largest parts of the world. Changes in those pattern and intensities are a major cause for biodiversity loss – but what makes high or low biodiversity?

We compare phytodiversity in systematic grids in three central European landscapes with different pattern and intensity of human impact. Within each grid cell the variety and identity of natural or human disturbances was detected and patches were differentiated. For each patch a list of higher plant species was recorded. Using multivariate techniques we analyze the correlation between certain disturbance pattern, impacts and site conditions using indicator values.

While in the most intensively used landscape phytodiversity is easily predictable using a hand full of parameters of the disturbance regime, pattern for less intensively used landscapes become more complex and site conditions become more important.

We discuss possible implications for biodiversity conservation and red list species conservation in the light of land-use change.

O4 - Vegetation change and homogenization of species composition in temperate nutrient deficient Scots pine forests after 45 years

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Human-induced N deposition has been identified as a major driver of vegetation change in Western and Central European forests in many studies, which may eventually lead to the homogenization and decrease of forest biodiversity. Pine forests on nutrient deficient sites are understudied in this respect, even though they account for the majority of forest sites in large parts of northern Central Europe. Due to the adaptation of their understory vegetation to nutrient poor conditions, we hypothesized that eutrophication i) drives vegetation change in the understory of nutrient deficient pine forests, which ii) is strongest on the most oligotrophic sites and thus iii) eventually leads to biotic homogenization across pine forest communities. We studied a large forest area in the Lower Spreewald region, Brandenburg, Germany. We resurveyed 77 semi-permanent plots after 45 years, including vascular plants, bryophytes and ground lichens. We applied multidimensional ordination of species composition, dissimilarity indices, mean Ellenberg indicator values, and the concept of winner/ loser species to identify vegetation change between years. Species composition changed strongly and overall shifted towards higher N and slightly lower light availability. Differences in vegetation change were related to initial vegetation type, with strongest compositional changes in the oligotrophic forest type, but strongest increase of nitrophilous species in the mesotrophic forest type. Despite an overall increase in species numbers, species composition was homogenized between study years, due to the loss of – often endangered – species (mainly ground lichens) on the most oligotrophic sites. The relative importance of atmospheric N deposition in the eutrophication effect is difficult to detangle from natural humus accumulation after historical litter raking. However, the profound differences in species composition between study years across all forest types, suggest that atmospheric N deposition is a driver of biotic homogenization in Central European Scots pine forests on nutrient deficient sites.

O5 - Restitution of degraded percolation mires in Western Pomerania by large-scale top soil removal

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The Peene River valley is located in Western Pomerania. It is one of the last ecological relatively intact river valleys in north-east Germany. It contains an exceedingly rich nature - especially flora has a high diversity. Today natural fans, particularly percolation mires, become rare. Due to agricultural usage soil characteristics changed irreversible. Degraded fens have a significant climatic impact. They are substantial sources for carbon, nitrogen and phosphate.

In north-east Germany reeds of mesotroph fens, especially alkaline habitats were distinctive. In the last two centuries these vegetation formations have been decreased enormously. It is estimated that the area in Mecklenburg-Western Pomerania declined from about 200,000 ha to less than 100 to almost 300 ha (Berg et al. 2004). To protect and restore these last areas ditches were closed in the Peene river valley. However after 20 years the targeted vegetation has not appeared yet.

A new approach is to remove the degraded and nutrient rich upper soil horizon to expose the undecomposed peat on large-scale. Thereby ground water should rise to the surface again and peat producing plants could resettle (Zerbe & Wiegleb 2011). Additionally the growth of fens could be new initialized and its function as a carbon and nutrient sink will be re-established. International attempts take already place, especially in the Netherlands and the UK. In Wales for example, species richness has been improved by turf stripping from 5 to over 100 plant species within 5 years (British Ecological Society / IUCN UK 2012). In Germany there are some promising results on small-scale (e.g. Schumann & Mauersberger 2009).

In the presentation the region and its ecological and floristic status will be described in detail. Also planned project measures and its objectives will be presented. The research project shall be supported by the “Federal Agency for Nature Conservation”.

O6 - Population structure suggests habitat-specific conservation for the threatened steppe plant species *Astragalus exscapus*

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Studies on the relation of plant population structure to the environment can help identify possible threats in changing habitats like the relict steppe grasslands of the central German dry region that are mainly threatened by abandonment of use. *Astragalus exscapus* is an endangered plant species and a part of the unique steppe flora of Central Europe. The species exists in continental grassland communities, which can be divided into “primary” dry grasslands and “secondary” semi-dry grasslands. We investigated the population structure of *A. exscapus* in 22 populations in central Germany. Three types of populations could be distinguished by their stage structure (stages: juveniles vs. small flowering vs. medium flowering vs. large flowering vs. non-flowering adults). 14 populations belonged to a “dynamic” population type which mainly consisted of small and medium (young) flowering plants. 5 populations belonged to an “aged” type (with nearly 50% large flowering adults) only found in dry grasslands. 3 populations belonged to a “regressive” type which was dominated by non-flowering adults not able to flower probably because of high competition and only found in dense and high semi-dry grasslands. While semi-dry grasslands had more small flowering and non-flowering adults, proportion of large flowering adults was higher in dry grasslands. Proportion of juvenile plants was generally low, but higher in habitats with open ground and short vegetation. We conclude that threats for *A. exscapus* are habitat-specific. In semi-dry grasslands biomass accumulation due to abandonment is a main threat and should be prevented by extensive grazing, while dry grasslands are less affected by succession and allow plants to grow large (but these may suffer from increasing droughts in future). On a landscape scale, a mixture of dry and semi-dry grasslands is needed for maintaining *A. exscapus* and artificial transport of seeds into suitable habitats without the species should be considered.

O7 - Biodiversity impacts of Chilean tree plantation forestry - Combining in-situ vegetation assessments and remote sensing data

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Chile has experiences rapid and intense land use transformation since the Pinochet government. Within the coastal mountain range of the VII. and VIII. administrative regions – the temperate zone – the predominant process has been replacement of native forests with exotic tree plantation (mainly with *Pinus radiata* D. Don and *Eucalyptus globulus* Labill.). This replacement process is worrying since the temperate zone of south-central Chile is considered a global biodiversity hotspot. Experiences with biodiversity conservation within plantations from other countries (like Australia) should not be transferred incautiously to Chile. Chilean forest plantations are designed to maximize economic benefits – not to maintain biodiversity. Despite frequently uttered worries on biodiversity impacts, little empirical evidence exists. This study provides such evidence by analyzing 158 vegetation assessments, comparing native forest remnants with the plantations that replace them. Results indicate a heavy impoverishment. Over 60% of species richness is lost within plantations and many endemic species are not found within plantations. The study then analyzes the replacement process, comparing land use maps produces with remote sensing imagery from 1975 to 2010. The emphasis is put on habitat loss and habitat fragmentation as major drivers of biodiversity threat. In a final step, the study combines both data sources – in situ and remotely sensed – in a knowledge

based species richness model. Thus, local measurements are regionalized using insights on the biodiversity diminishing processes that are gained from both data sources. The results are relevant to a broader audience interested in biodiversity conservation within managed landscapes – especially within biodiversity hotspots. They are furthermore relevant to future planning scenarios for Chilean Patagonia, since the deforestation that is almost completed in the temperate zone, is recently beginning in Chilean Patagonia.

O8 Assessment of landscape transformation through plantation forestry and its impact on biodiversity in chilean Patagonia

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In Chile, forestry became a major economic sector in the last decades. Forestry plantations with non-native species, for the most part form the genus Pinus, cover up to 50% of lands surface in some regions in central Chile today. Initially they were planted for conservation purposes, i.e. to reduce landslide probability. Since in south-central Chile forest companies seem to be running out of free space for plantation establishment, a southward tendency towards Chilean Patagonia can be expected.

Using remote Sensing data the land-use of 1984 is assessed and compared with the land-use 2012. Fast growth of forestry plantations around the capital city of the Region, Coyhaique, can be found, yet these plantations are still small compared to other parts of South America.

Although native Nothofagus-forests and -shrublands still cover large areas in Chilean Patagonia due to the low population density, near to the cities and roads these native forests only remain in higher altitudes or at steep slopes while plantations are extending fast.

In a field campaign in 2012 the biodiversity of natural vegetation was compared to the pine plantations. Within these plantations, biodiversity is significantly reduced. Not only species richness is lower, but also species evenness is at a lower level because of management practices are adopted from south-central Chile. Furthermore, invasive species are more abundant under exotic tree species. Exotic trees are spreading out of the plantation areas and are found all around Coyhaique, although there are few plantations older than 30 years.

This can be seen as an early warning sign on how the actual way of land use intensification will stress negative environmental effects, especially on the biodiversity, if not these unique forests will be preserved with adequate land use and forestry management.

O9 - Future rainfall patterns will reduce arthropod abundance in model arable agroecosystems with different soil types

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Climate change scenarios for Central Europe predict a seasonal shift in precipitation patterns with fewer but heavier rainfalls and longer drought periods during the growing season and more precipitation during winter. This is expected to alter arthropods living in natural and agricultural ecosystems with consequences for several ecosystem functions and services they provide. In order to better understand the effects of future rainfall patterns and soil types on aboveground arthropods inhabiting agroecosystem, we conducted an experiment in winter wheat cultivated in a lysimeter facility near Vienna, Austria, where the soil types calcaric phaeozem, calcic chernozem and gleyic phaeozem were subjected to long-term current vs. predicted rainfall patterns according to regionalized IPCC projections for 2071-2100. Aboveground arthropods were assessed by suction sampling in April, May and June 2012. We found significant differences in mean total arthropod abundances between the sampling dates with 20 ± 2 m^{-2}, 90 ± 20 m^{-2} and 289 ± 54 m^{-2} in April, May and June, respectively. Across all three sampling dates, future rainfall patterns significantly reduced the abundance of Araneae (-43%), Auchenorrhyncha (-39%),Coleoptera (-48%), Carabidae (-41%), Chrysomelidae (-64%), Collembola (-58%), Diptera (-75%) and Neuroptera (-73%). Generally, different soil types had no effect on the abundance of arthropods. Arthropod diversity was unaffected by rainfall patterns or soil types. Correlation analyses of arthropod abundances with crop biomass, weed density and abundance suggest that rainfall indirectly affected arthropods via changes on crops and weeds. In conclusion, these results show that future rainfall patterns will reduce the abundance of a variety of aboveground arthropods in winter wheat with potential consequences for their role as herbivores, biological control agents or food source for predatory fauna within agroecosystems.

O10 - Some like it hot? - Adaptive potential of *Bombina variegata* to climate change

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Global climate change and anthropogenic influence alter habitats rapidly and severely impact the survival chances of many species. Amphibians are especially inflicted by these environmental changes, due to their life history with an aquatic larval stage and terrestrial adults. Therefore, the adaptive potential to changing temperatures and altered water availability are of particular importance. The Yellow-Bellied Toad, *Bombina variegata* prefers small temporary ponds with little vegetation, mostly wetlands and flooded areas, but due to habitat fragmentation populations are getting more isolated. Larger populations live in habitats which are fully exposed to sun and tadpoles may already live at their thermal limits, for examples in quarries. Other populations, however, live in forested habitats with temperate conditions and are separated by streets or bigger patches of disturbed areas. In experiments we investigate if these populations differ in their environmental (e.g. thermal) requirements, to predict the adaptive capacity of the species to expected changes in temperature and precipitation pattern and thus estimate their survival probabilities. Therefore, we conducted transfer-experiments where tadpoles were reared under their native and an alternative environment, to test the phenotypic plasticity of tadpoles of the Yellow Bellied Toad. To compare the developmental progress within populations and habitats, the tadpoles' size and developmental stages were recorded weekly and at the end of metamorphosis. Additionally time to metamorphosis, weight of the metamorphs and temperature in the habitat were measured. We could detect regional distinctions in developmental time, size and weight between populations and season of the year. These results indicate that populations from different habitats follow distinct strategies and therefore need particular conservation plans.

O11 - Weather effects on the long-term breeding success of a large White Stork *Ciconia ciconia* population

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Facing rapidly changing environments, it is crucial for both nature conservation and ecological science to better understand factors influencing species survival and reproduction. Climate change, for example, is one hot topic in recent days, as it might induce modifications of ecosystems that could result in decline or even in extinction of single species. For a better understanding of impacts on local fauna, we investigated weather effects on the breeding success of the White Stork (*Ciconia ciconia*), a migrant bird species of special conservation concern. Based on a comprehensive long-term monitoring data set from the federal state Brandenburg, the largest White Stork population in Germany, we modelled the relation between reproductive success and weather parameters during the egg-laying, breeding and early post-hatching phase. During this time, we hypothesise that weather directly influences offspring survival due to reduced thermoregulation ability of chicks at such young age. Our results show that weather certainly is a crucial factor for the reproductive success of White Storks and may impact chick survival at various stages during the breeding season. Nevertheless the effect also varies between years, indicating that additional factors such as land use must play an important role for the White Stork's fitness.

O12 - Snails keep the pace: shift in upper elevational limit on mountain slopes as a response to climate warming

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Recent climate warming induces physiological and ecological responses in plants and animals throughout the world, apparent in the phenology and distribution of species. Alpine areas belong to those regions expected to experience above average warming with continued global climate change. There is increasing evidence that the range of plants and animals are moving in response to recent climate warming towards higher elevations. We investigated changes in the upper elevational limit of the land snail *Arianta arbustorum* by repeating historical records from 1916–1917 on nine mountain slopes in the Swiss National Park in 2011–2012. We found that the upper elevational limit for snail populations has risen on average by 164 m in 95 years, accompanying a 1.6 ^{o}C rise in mean annual temperature in the investigation area. The higher temperature results in an upslope shift of the vegetation and in a prolonged activity period of the snails. Upslope extension of snail distribution was not influenced by the inclination of the slope but it was larger on south-exposed slopes (mean: 233 m) than on north to north-east exposed slopes (122 m). On some slopes we found that the snails have already reached natural barriers (vertical rock walls with no soil) preventing any further upward dispersal. To our knowledge, this is the first evidence for an invertebrate species with low dispersal capacity ascending to higher elevations in a mountain area in response to climate warming.

O13 - Likely impacts of climate change on forest structure in the Bavarian Forest National Park

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The Bavarian Forest National Park (BFNP) is a part of the Greater Bohemian Forest Ecosystem, which is the largest strictly protected contiguous forest area in Central Europe. This forest offers a wide range of ecosystem services, especially carbon sequestration, preservation of flora and fauna biodiversity, recreation use and aesthetic beauty. Many of these functions are strongly connected with forest structure, which is characterized by species composition and tree size distributions at different spatial scales. In the last decades, forest structure has strongly changed due to multiple small- and large-scale disturbances (wind-throws and bark beetle outbreaks). If this forest structure is predicted to change in the future according to well-known processes of natural succession, the impact of climate change on this evolution is still unclear.

We conducted a prospective study with the forest gap model ForClim simulating the impacts of climate change on short-term forest dynamics on the BFNP. The likely increase in temperatures and decrease in rainfalls is predicted to strongly impact forest structure by modifying establishment, growth and mortality of tree species, but in a different extent, depending on their sensitivity to drought and higher temperatures. In this wet and cold area, common beech (*Fagus sylvatica*) should be favored by these new climatic conditions contrary to Norway spruce (*Picea abies*) leading to changes in forest structure at stand scale. Moreover, as these species-specific responses would differ among stands according to their topographic situation (*e.g*. elevation), the spatial heterogeneity of the forest structure at landscape scale would also be modified. We conclude by discussing the implications of the observed shifts in forest structure on ecosystem services, and how wildlife management could potentially be used to maintain high forest heterogeneity in the BFNP.

O14 -Living in isolation: the role of functional connectivity for patch occupancy in grassland specialists

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Habitat specialists living in metapopulations are sensitive to environmental changes such as habitat fragmentation. In most studies, the effects of fragmentation on such species are analysed based on Euclidean inter-patch distances. This approach, however, ignores the role of the landscape matrix. Recently, therefore, functional distances that account for the composition of the landscape surrounding habitat patches have been used more frequently. However, the predictive power of functional and non-functional connectivity for patch occupancy by habitat specialists has never been compared in a multi-species approach.

In this study we evaluated the effect of the landscape matrix on the distribution of 13 habitat specialists from three different insect orders in fragmented calcareous grasslands. We modelled species' occurrence using the classical approach (based on Euclidean inter-patch distances) on the one hand and the functional approach (based on least-cost modelling) on the other hand. We tested three different sets of resistance values and rankings for the functional approach. In each case, habitat connectivity was calculated using Hanski's index.

We found that each of the functional connectivity measures provided better results than the non-functional approach. In addition, isolation effects were only detected in some species when functional rather than Euclidean distances were used.

In order to take into account possible effects of the landscape matrix on patch occupancy by habitat specialists, future metapopulation studies should use functional rather than Euclidean distances whenever possible. However, it is important to note that detailed land-cover data is not always available. For practical applications we therefore recommend a 'simple approach', which provided results that were almost as good as our best but much more complex connectivity measure, even though it only separated the landscape matrix in open land and woody areas. Such coarse data are easier to obtain and analyse than detailed maps containing different types of land-cover.

O15 - Climate change in fragmented landscapes: Modeling the effects of structural connectivity on the regional survival of functional types

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Habitat loss is considered as a key driving force of biodiversity loss often in combination with climatic changes including rising temperatures and shifting precipitation regimes. In order to conserve especially endangered species and biodiversity hotspots, conservation measures therefore need to take into account effects of both drivers on habitat and population performance. There are mainly two conserving measures which have been discussed in this context, and which are often seen as alternatives: an improvement of habitat connectivity vs. an improvement of habitat quality. So far, there is no clarity as to which management measure is more effective considering the ecosystem and species of interest. We here used a spatially-explicit modeling approach based on animal functional types in order to test these contrasting conservation measures for their ability to compensate climate change effects in fragmented landscapes. Particularly the following questions have been addressed:

1. Which management measure is more effective for functional types representing species, which differ in their overall abundance and their local population turnover rates?
2. Does the effectiveness of measures depend on the level of habitat fragmentation?

The model represents landscapes of different fragmentation levels. Three different climate change scenarios according to the IPCC report of 2007 are taken into account together with four different functional types varying in their overall abundance and local turnover rate.

Model results show that an improvement of habitat quality is most effective considering all fragmentation levels, functional types and climate change scenarios tested. However, given the negative effects increasing fragmentation levels have on population viability, the importance of additionally improving patch connectivity grows with increasing landscape fragmentation. In fact, simulations reveal a fragmentation threshold, above which habitat patches become too small for habitat quality measures alone to be sufficient and additionally increasing habitat connectivity is pivotal.

O16 - Where there is one, there are many; or is the Nimba toad's presence dependent on particular environmental parameters?

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Mountainous systems are fragile and their climatological features are prone to modification due to global climate change or anthropogenic induced alterations. In West Africa the area with the highest reported biodiversity for amphibians are the Nimba Mountains. These mountains are situated in the triangle between Guinea, Ivory Coast and Liberia. During the rainy season presence of fog, much lower temperatures than the surroundings and rapidly changing weather conditions are noticeable features on the mountain chain. Amphibians are ectotherms and have a semi-permeable skin, which results in a strong dependence on temperature and humidity. In the tropics one large risk for amphibians is over-heating and hence, lower temperatures and higher humidity should be preferred.

The viviparous Nimba toad (*Nimbaphrynoides occidentalis*) is endemic to the Nimba Mountains. Because of its viviparous reproduction (gestation time of nine month, during which the mother nourishes her young) they are independent of open water and are able to occur in the high altitude grasslands covering most of the mountain chain. Within these grasslands three populations can be distinguished, separated by a couple of kilometres of high altitude grasslands. Hence, the question arises why at three locations Nimba toads can be recorded, while in other areas of the same habitat they are absent. And whether this restricted distribution is due to particular environmental conditions and if so, what this may mean for the persistence of *N. occidentalis* after possible future climatological and environmental changes. To understand these dependencies we examined with generalised mixed models and generalised additive mixed models whether environmental and climatologic parameters may explain the patchy distribution of Nimba toads and how this endemic species may be protected to persist in the future.

O17 - Dietary plasticity of generalist and specialist ungulates in the Namibian desert revealed by stable isotope analysis

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Desert ungulates live in adverse ecosystems that are particularly sensitive to degradation and global climate change. Here, we asked how two ungulate species with contrasting feeding habits, grazing gemsbok (*Oryx g. gazella*) and browsing springbok (*Antidorcas marsupialis*), respond to an increase in food availability during a pronounced rain period. We used a stable isotope approach to delineate the feeding habits of these two ungulates in the arid Kunene region of Namibia. Our three-year field period included two years of drought when food availability for ungulates was lowest and a medium year with pronounced rainfall. We documented thirteen isotopically distinct food sources in the isospace of the study area. Our results revealed a relatively high dietary plasticity of gemsbok, which fed on a mixture of plants, including more than 30% of C3 plants during drought periods, but almost exclusively on C4 and CAM plant types when food was plentiful. During drought periods, gemsbok diets also consisted of up to 25% of *Euphoria damarana*; a CAM plant that is rich in toxic secondary plant compounds. In contrast, springbok were generalists, feeding on a higher proportion of C3 than C4/CAM plants, irrespective of environmental conditions. Our results illustrate two dietary strategies in gemsbok and springbok which enables them to survive and coexist in the hostile Kunene ecosystem

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O18 - Maximum entropy modelling of Caatinga plant species in a semi-arid area of northeast Brazil

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Terrestrial and aquatic ecosystems are subjected to current and future anthropogenic changes. Human interventions such as the construction of a dam might affect landscape patterns significantly. In the last century Brazil has constructed over 600 hydroelectric power plants due to the increasing demand for energy. The different usages initiate impacts to natural land use patterns, which could result in environmental problems such as loss of biodiversity. The whole study area is situated in the Sao Francisco River watershed and contains two main biographic regions (Caatinga and Cerrado). Our scientific focus is on the impacts of land use and climate change to biodiversity. In the first step we assess the current status of plant diversity in the landscape applying a habitat model and develop potential land use change to the landscape pattern using a land use model on the regional scale. In the second step several future land use and climate change scenarios will be integrated into

the habitat model to assess the consequence of environmental change on biodiversity. Finally, the spatial modelling methods will be implemented in a decision support system. Although there is much information of plant species in the research area, there are still many knowledge gaps of spatial distributions on-site. As we are dealing with presence only data in this case, we present a maximum entropy approach for modelling Caatinga plant species. For mapping biodiversity and conservation planning habitat modelling is a useful technique. For a general understanding of the floristic systems, we model the distributions of 10 key plant species. To achieve this, we use the software MaxEnt, which can create distribution maps on the basis of species occurrence and environmental variables at a high spatial resolution (1 km) at a regional level (670.000 km^2). We generated a spatial database including several “background parameters” (Topography, Pedology, Climate, Land Use & Remote Sensing). First model runs have confirmed the applicability of the used method for the semi-arid conditions in northeast Brazil. The models enables accurate distribution mapping of shrub and forest formations in the Caatinga biome and was optimized by the integration of remote sensing data (e.g. vegetation indices).

P1 - Impacts of climate change on bird communities in the "Lüneburger Heide": what are the priorities for nature conservation?

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Over the next decades we expect changes in the composition of bird communities due to projected rising temperatures and shifting precipitation regimes. The first signs have already been observed as several bird species have expanded their ranges northwards (Parmesan & Yohe 2003). Additionally, across Europe populations of bird species with low thermal maxima declined at a higher rate than those of species with higher thermal maxima (Jiguet et al. 2010). Identifying and quantifying possible impacts on bird communities will improve management strategies for nature conservation thus, mitigating the negative effects of climate change.

‘Lüneburger Heide’, situated in northern Germany, is an area of high value for nature conservation with several Special Protection Areas and a high diversity of bird species. We estimated the extent as well as the direction of possible future changes in the composition of bird communities from this region using a space-for-time approach. Accordingly, we identified regions within Europe which have the same climate conditions today that are projected for the study area for the end of the 21st century. We found such future climatically analogous regions in the northern, western and central parts of France depending on the climate simulations used. We assessed possible turnovers by analysing the similarities and differences of the species pools of both our study area and the corresponding future climatically analogous regions and compared our results with results from the widely-used climate envelope models for breeding birds by Huntley et al. (2007).Both approaches generally showed a high accordance, but Huntley et al. (2007) projected a greater number of species being absent from the bird community of the study area than we did. This was especially true for wetland bird species. Huntley et al. (2007) projected that several of these species would not occur in the Lüneburger Heide. However, these same species will be able to tolerate the Lüneburger Heide's future climate, according to the predictions which used the climatically analogous regions.

Since the total number of wetland birds was positively correlated to the proportion of wetlands within the regions, our findings emphasize the importance of wetland restoration and protection in counteracting the projected impacts of climate change.

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P2 - Thermal and drought tolerances of lichens as indicators of climate warming in an arid South African ecosystem

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Elevated temperatures, reduced fog and dew precipitation accompanying climate warming are expected to have adverse effects on sensitive lichen species which could serve as early indicators of environmental change. Responses of several different lichen species to heat and drought stress were examined under both laboratory and natural conditions. Under laboratory conditions moistened lichen species were exposed for short 2-hour periods in a forced draft oven to increasing temperatures. Under natural conditions, hexagonal open-top chambers clad with clear acrylic placed over different lichen populations artificially elevated maximum daily temperatures (average: 3.8^{o}C increase) and partly exclude fog and dew precipitation (average: 46% decrease). Similar chambers clad with 60% light transmitting shade cloth partly excluded fog and dew precipitation (average: 49% decrease) without altering temperatures. Compartments of equivalent open-top chamber basal dimensions clad with 5 cm diameter steel mesh comprised the controls which represented natural conditions. Photochemical responses of lichen photobionts to heat and drought stress were measured with modulated and rapid rise fluorescence meters and combined respiratory responses of photobionts and mycobionts to heat and drought stress measured with an infrared gas analyzer. Diminished photochemical quantum yields and respiration rates were observed in all lichen species with elevated temperatures with photochemical quantum yields more sensitive to heat stress than respiration rates and lichen species from cooler coastal habitats more sensitive to elevated temperatures than those from hotter inland habitats. Progressive reductions in photochemical quantum yields were also observed in moistened lichens under completely natural conditions as temperatures increased from early morning through to midday indicating that an anticipated shift from a winter to summer rainfall pattern could also detrimentally affect lichen photosynthesis.

P3 - Citizen science project: farmers monitor plants and animals across Austria

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Farmers influence habitats of flora and fauna by their way and intensity of land cultivation. Consequently, they are the key persons to be addressed for maintaining biodiversity in the cultural landscape.

This project focuses on education and science and involves more than 650 farmers who monitor selected plant and animal species on low fertile grasslands. In the educational part, farmers get to know the animals and plants inhabiting their grasslands. In the science part, farmers track changes in abundance of species from one year to the other; these data are then related to management measures, soil conditions or climatic trends. The monitoring sites are randomly distributed across Austria covering lowland and mountainous regions. Criteria for the selected plants and animals are *inter alia* (i) suitability as an indicator species of low-productivity grassland, (ii) easy identification in the field and (iii) potential as flagship-species. Once per year the participants submit their observations including cultivation activities at the study site via an online form. In contrast to many other citizen science projects, here every participant monitors the same sampling site with the same indicator species during several years. Until now (Apr. 2013), 249 plant species and 66 animal species were counted and monitored. Research questions addressed include: (I) Which management measure affects most species? (II) What is the impact of different soil types? (III) To what extent do climatic trends interfere with grassland management?

Given the interdisciplinary character of this project outputs are to be anticipated for both agriculture and nature conservation. Farmers learn directly which way of cultivation influences the species at their grasslands. We think by this approach a more sustainable nature conservation can be achieved. Furthermore, this project shows a way to integrate new research findings into agricultural practice, without patronizing the farmers.

P4 - The PRACTICE approach: an integrated global perspective for combating land degradation in drylands

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Dryland degradation and the related loss of ecosystem services is a major threat to biodiversity and livelihoods of local land users. Coupled effects of increasing anthropogenic pressures, unsustainable land management and climate change alter ecosystem resilience and may result in profound shifts of socio-ecological environments. It is due to these complex relationships that approaches are needed for the integrative evaluation of management and restoration options for land degradation mitigation and ultimate identification of best practices to be implemented for improved decision-making.

PRACTICE (Prevention and Restoration Actions to Combat Desertification: An Integrated Assessment) is a Support Action of the European Commission Seventh Framework Programme. PRACTICE aims at linking science to society in a bottom-up approach that allows the systematic evaluation of land-user actions to combat land degradation. A participatory assessment protocol (IAPro) is used that assumes the mutual human-environment interactions in land-use change. It follows a structured sequence of steps that offer a path for knowledge exchange among all stakeholders, including scientists and policy makers. IAPro combines traditional (local) knowledge with scientific expertise, as well as biophysical and socio-economic assessment data and stakeholder perspectives.

Steps of IAPro include the locally-contextualized identification of a multi-stakeholder platform, applied degradation-mitigation actions, as well as site-specific indicators to be combined with common science-based indicators representing key ecosystem services. The indicators are used for the assessment of actions by eliciting their relative importance from the stakeholders in a participatory weighting exercise, providing opportunities for social learning and consensus building. A multi-criteria decision analysis integrates the stakeholder perspectives with indicator-specific biophysical and socio-economic assessment data, highlighting outranking relationships between the alternative actions.Case studies from dryland areas in nine countries have demonstrated IAPro’s potential for the consistent but also adaptive assessment of a large variety of actions in varying socio-economic, cultural and environmental contexts.

P5 - Characterizing and localizing high nature value (HNV) farming systems in Lower Saxony, Germany

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Since the 1950s, farming systems across the European Union (EU) have changed from low-intensity, small scale and mixed farms to high-intensity, large scale and specialized farms. However, the magnitude and direction of change in farming systems varies: More fertile areas in the lowlands are affected by agricultural intensification while agriculturally marginal areas are affected by abandonment. Both of these processes are known to have significant detrimental impacts on farmland biodiversity.

Many species in Europe are adapted to low intensity - and often traditional - farming systems. Such farming systems that support high levels of biodiversity are called high nature value (HNV) farming systems. The HNV farming concept was introduced in the early 1990s, and the EU has recognized the importance of HNV farming for the conservation of farmland biodiversity. However, past and current agricultural subsidies and conservation measures have mainly failed to safeguard HNV farmland and the respective farming systems. Until now, no methodology for the characterization and localization of HNV farming systems has been developed for Germany.

Here we present an approach for characterizing and localizing HNV farming systems based on the *Integrated Administration and Control System* (IACS) database. This database is used for record keeping and maintenance of statistical information for direct support schemes for farmers under the Common Agricultural Policy and provides detailed information on farm characteristics such as livestock animals and crop types. Using the federal state of Lower Saxony as a case study, this high resolution farming system data was used for the introduction of a farming system approach into the mapping of HNV farmland. Our results can inform and guide policy makers about which farming systems and regions would be most efficient for targeting agri-environmental support for the maintenance of HNV farming.

P6 - Are effects of historical landscapes still reflected in present day plant species richness?

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Local extinction of species or entire communities can occur with a substantial time lag following changes of habitat composition and configuration. This delayed extinction is known as extinction debt and is highly relevant for biodiversity conservation because current species richness might not yet reflect the limited area and fragmentation of habitat available. Extinction debts have still been rarely assessed empirically because of high data demand: The former and current distribution of the habitat in focus must be known, and at least the present-day species composition of the remaining habitat patches.

For wetlands of the Canton of Zurich (Switzerland), the spatial distribution between 1850 and 2000 has been reconstructed at intervals of 50 years (Gimmi et al. 2011), and we collected present day species composition of vascular plants and bryophytes in more than 50 remaining wetland patches. These data allow us to investigate links between past and present-day wetland cover and occurrences of plant species typically found in wetlands, and to test how long-lasting effects of past wetland distribution are. In our contribution we will address the following questions: (1) Are past wetland area and configuration reflected in present-day richness in wetland species (vascular plants, bryophytes) in the Canton of Zurich? (2) Which properties of wetland patches (size, spatial connectivity, etc.) best explain present-day species distribution? (3) Are time lags in the response of species richness to habitat fragmentation dependent on life-history traits?

Gimmi U, Lachat T, Bürgi M 2011. Reconstructing the collapse of wetland networks in the Swiss lowlands 1850–2000. *Landscape Ecology* 26: 1071-1083.

P7 - How to assess vegetation change of protected grasslands on a national scale?

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We present a complex probabilistic sampling design of permanent plots for the long-term monitoring of protected dry grassland vegetation in Switzerland. On the permanent plots complete species lists of vascular plants are assessed. The monitoring focus is thus on species composition and on indicators derived from these data (e.g. number of red list species or habitat specialists). The data collected in the first year of the monitoring are compared to older data which were sampled in the same grasslands. However, these older data have been sampled subjectively. Such data are known to suffer from various biases. We analyze the effects of the sampling designs and discuss possible implications on trend estimations.

P8 - Impacts of land use on the biodiversity of vertebrates in Southwestern Madagascar

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The study region in Southwestern Madagascar is one of the most unique and biologically rich drylands on earth. However, its ecosystems suffer from unsustainable land use practices which have led to habitat fragmentation and degradation due to livestock grazing, slash and burn agriculture, and charcoal production. Since research in Madagascar has been mainly focused on “pristine” ecosystems neglecting the anthropogenically used habitats, very little is known on the responses of plants and animals to anthropogenic disturbance.

Within a project to assess the relationship between biological diversity and land management we analyzed the response of selected vertebrate groups (birds, reptiles and mammals) to different forms of land use and anthropogenic disturbance in order to evaluate the potential of anthropogenic landscapes to act as corridors or buffer zones around protected areas. The distribution of the target species was determined by standardized inventories to allow quantitative estimates of species composition and abundances in different forms of natural and agricultural used lands.

First results show that all studied animal groups are affected by habitat alterations, although to different degrees. Contrary to expectation, 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. Although it is not possible that all of the region’s biodiversity is preserved in anthropogenic land use systems, these systems could nonetheless be designed to act as corridors between largely pristine forests and buffer zones to facilitate the exchange of individuals between populations.

This study is part of a BMBF funded project on development of sustainable land use in Madagascar (“SuLaMa”).

P9 - Insect diversity in the forest steppe ecotone in Western Siberia

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The Western Siberian lowlands contain huge areas of natural and seminatural low-intensively used grasslands and peatlands. For the surveyed study area, the Tyumen region, intensification and expansion of agricultural land use is expected, leading to direct losses of grasslands through land reclamation, which will negatively impact neighbouring areas through drainage and increased nutrient input.

The aim of this study is to assess the importance of this region for biodiversity and the consequences of land use change and further to provide practical management tools and adaption strategies to deal with recent and future ecological changes. The study plots are located in three study areas in (semi-)natural grasslands, grasslands on former arable land, croplands and forests. Butterflies and grasshoppers were sampled as model groups for insect diversity, as well as environmental parameters, by using the box quadrate method for grasshoppers and through standardized transect walks for butterflies.

Our results show overall high species numbers and densities for both animal groups in grasslands, particularly in those located in grassland-forest complexes. Especially in forests we found a high diversity of butterflies and on croplands comparatively diverse grasshopper communities.

P10 - Investigating the reasons for population extinction of the steppe plant *Scorzonera purpurea* in Saxony-Anhalt and Thuringia, Germany

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Steppe-like grasslands are extreme species-rich and therefore important for maintaining biodiversity. In Germany, they are relicts of the vast steppes that covered Europe in the late Pleistocene. Small and fragmented stands of these grasslands have outlasted at steep southern-faced slopes where natural afforestation was hindered. However, without human activities e.g. clearing and grazing steppe-like grasslands would not have persisted to the present. Today's steppe-like grasslands in Germany occur on small isolated hills in the intensively used agricultural landscape. Habitat loss since the last century by abandoning traditional land use in form of grazing has led to the extinction of many of steppe-like grassland stands. This development is thought to be a threat for many plant species of steppe-like grasslands such as the Purple Viper's Grass, *Scorzonera purpurea*. Just 150 years ago *S. purpurea* was widespread in steppe-like grasslands in Saxony-Anhalt and Thuringia. Today it is considered threatened. The species is almost extinct in Saxony-Anhalt and in Thuringia it concentrates onto just only a single region.

In this study we investigate the reasons for the severe decline of the species over the last 150 years. Habitat characteristics of former and extant populations e.g. size and isolation degree of the habitats as well as geological substrate type and vegetation type will be related to the fate of the populations (existent vs. extinct) in order to determine reasons for their extinction (or persistence).

The aim of this study is a better understanding of the extinction processes in *S. purpurea* in order to conserve recent populations.

P11 - BOKUroadkill: a citizen science project on the impacts of roads on fauna

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Habitat fragmentation by roads is a severe impact for many animal species, particularly for those with high mobility or seasonal migration behaviour, such as mammals or amphibians. As a consequence, roadkill is one of the main reasons for the decrease of populations of several animal groups. In Austria, official data of roadkills are only available for huntable wildlife. In the year 2012, amongst others 24852 European hare, 36865 Roe deer, 1414 European badger were killed on roads. However, there are no data available on the effects of roads on non-huntable wildlife or red list species such as European hedgehog (*Erinaceus europaeus*) or European green toad (*Bufo viridis*). In this project we investigated whether (I) the surrounding area influences number of species and individuals killed on roads, (II) wheather conditions affect the number of roadkills and (III) roadkills are associated with speed limits on the roads. To answer these research questions we launched a citizen science project where participants report roadkill findings via a custom-made smartphone app or an online form. The data entry includes inter alia coordinates of the roadkill location, taxonomic information of the killed animals, information about the surrounding habitats and if possible an image of the roadkill. The handling of the app is very easy, hence enabling its integration in teaching at schools or universities in order to connect students with both science and nature conservation issues. Two months after the start of the project, already 300+ volunteers reported roadkill data. Preliminary results suggest, that amphibians tend to be killed more often in urban areas and mammals in open areas with a higher speed limit. No clear association between wheather conditions and roadkill were found so far. Besides answering our research questions findings of this project also allow to locate dangerous spots for animals and could help to set up nature conservation actions.

P12 - Fragmentation effects on different levels of biodiversity of a tropical amphibian assemblage

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Habitat fragmentation is a process that may lead to the loss of biodiversity, but there is no consistent pattern on species' and communities' reactions. Therefore, ecosystem consequences remain poorly known. Differences in species' extinction susceptibilities may result in changes in community structures and food-web interactions, and hence ecosystem functioning. With regard to future conservation efforts it is crucial to understand the full dimension of fragmentation effects on biodiversity and hence considering different aspects of biodiversity. We aim at understanding patterns of biodiversity in a fragmented landscape combining species richness, species composition, and functional diversity. Our study site is Ranomafana National Park (RNP) and its surroundings, a mid-altitude rainforest ecosystem in Madagascar that is exceptional in its amphibian diversity. The surrounding area is, due to slash and burn agriculture, highly fragmented. We determined species richness and composition along transects distributed along streams and in terrestrial parts that were spread over three major habitat types: RNP, forest fragments, and the matrix. We calculated functional diversity using a set of different ecological, morphological and life history traits. We found no differences in species richness along stream transects between habitats. However, species richness along terrestrial transects decreased with increasing degradation, with most species found in RNP and least in the matrix. In contrast, we found distinct differences in species composition between all three habitat types along stream and terrestrial transects. Functional diversity (FD) along stream transects was not affected by fragmentation, but FD of terrestrial assemblages was lower in the matrix than in RNP. We conclude that forest fragmentation leads to local extinctions in terrestrial assemblages and partly in stream assemblages. However, along streams species are replaced by functionally redundant species.

P13 - Epizoochory by the hooves - the European bison (*Bison bonasus* L.) as a dispersal agent of seeds in an open-forest-mosaic

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Seed dispersal is an important process to maintain biodiversity in landscapes. Large herbivores are important vectors for the long-distance dispersal of seeds in various habitats, both attached to animals (epizoochory) and via gut passage (endozoochory). The majority of studies on epizoochory have examined dispersal in the fur of domesticated ungulates. Studies on epizoochory by wild ungulates are important to understand dispersal processes in many habitats, but rare due to methodological constraints. We studied epizoochory of seeds by European bison in an open-forest-mosaic (nutrient poor grassland and heathland, mixed forest) in NW Germany, where bison had been introduced for the purpose of nature conservation. Due to the given conditions at the study site, it was possible to apply a method by which hoof material of moving bison was indirectly collected. We identified a total of 1082 seeds from 32 plant species (79 seeds per 100 g dry mass) in the hoof material. The three most abundant seed species were *Polygonum aviculare, Agrostis* *capillaris* and *Betula* spp., respectively. There was a large heterogeneity in seed morphology and plant species traits. Seeds originated from various biotope types of the study area, while the majority of seeds derived from trampled areas. Compared to the background vegetation, dispersed plant species had a higher seed longevity index, indicating that many seeds were picked up from the soil seed bank (secondary dispersal). Analyzing epizoochory ranking indices (www.seed-dispersal.info) of dispersed seed species revealed that transport in the fur is of minor importance for many dispersed species, i.e. epizoochory by the hooves turns out to be complementary to epizoochory in the fur. We conclude that European bison does not only function as an effective endozoochorous dispersal agent, but also disperses a considerable diversity of seed species through trampling. Further research should be based on an integrative approach to understand the long-term synergetic effect of this ecological process and its effect on to the plant communities and vegetation structure.

P14 - Intra-specific body size of pollinators increases with habitat fragmentation

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Pollinators have been shown to be especially affected by habitat fragmentation showing declines in abundance and diversity. The ability to move between the remaining habitat fragments is depending on the dispersal capacity of a species. This leads to shifts in species composition to a higher proportion of large compared to small bee species with increasing isolation of habitats. While these size-specific shifts in bee species compositions with increasing habitat isolation are well established, little is known if individuals within species are similarly affected. To examine the relation between body-size within species and environmental factors, we measured the Inter-tegular distance (ITD) of 791 females of the species *Andrena flavipes* which were collected from 20 flowering fields in an agricultural landscape near Marburg, Germany, spanning a gradient from low to high amounts of grassland within a 500m radius around them. Bees were sampled over a period of seven weeks during the beginning of June and the end of July in 2011. The ITD has previously been shown to be a good indicator for the mobility. Comparable to large species in general, lager individuals of the medium-sized *A. flavipes* were found in all habitats, while small individuals were confined to well connected habitats, leading to a negative correlation between the mean ITD and the percentage of grassland in the surrounding landscape. To our knowledge, this is the first example of habitat fragmentation selecting for larger individuals within a pollinator species.

P15 - Functional re-connection of calcareous grassland remnants: Incorporating local and landscape-scale factors in management and restoration

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Calcareous grasslands are the most species-rich ecosystems in Central Europe. Due to land-use changes during the past century only few isolated and often degraded remnants exist today. To provide new habitats for the threatened species, many calcareous grasslands have been restored during the past years. The aim of the ongoing project is to identify the limiting factors for plant dispersal between and persistence on both, historical and restored grasslands and to inform how to effectively counteract local and regional species loss from calcareous grassland metacommunities. These factors will be assessed in a series of field studies and experiments.

In the first field study (2012-2013), species composition of calcareous grassland remnants is sampled in two study areas in the German Alpine Foreland. From this dataset, measures of community structure will be calculated and modeled against local and landscape factors. This will enable us to inform decision makers whether spatial arrangements (through enlargement or reconnection by restoration sites), soil conditions or management type have to be improved for each single grassland separately in order to achieve the desired plant community.

In the second field study (2014), the same community and descriptor variables will be sampled from restoration sites. By applying the metacommunity conceptual framework, we aim to identify the spatial dynamics within the regional set of restored and historical grassland communities. This will allow statements on whether current restoration measures are successful in providing new habitats in terms of reachability, abiotic and biotic site conditions and are thereby able to functionally re-connect ancient grasslands.

In a complementary field experiment conducted in March 2013, we aim to test how community assembly processes change along environmental gradients in restoration settings. As these processes drive the structure of plant communities, their knowledge will help to make reliable predictions on the outcome of restoration efforts under varying site conditions and to inform decision makers how to choose and prepare restoration sites and to select adequate seed mixtures. This will ensure that restoration sites are able to functionally re-connect ancient grassland remnants by means of abiotic and biotic site conditions.

P16 - Influence of grazing, soil, relief and climate change on the biodiversity of the National Park Asinara (Sardinia) - Project presentation

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Biodiversity is endangered, particularly, by unsustainable land use. Through intensive land use and climate change, regions with high biodiversity like the Mediterranean are at risk.

High biodiversity is characteristic for areas which provide a variety of habitats. These habitats can result from highly textured landscapes, which show topographical structures like hills and valleys, or are influenced by the local distribution of soil types, or are under the impact of large grazing animals. Thus, grazing may, as long as it is not intensive, contribute to the conservation of biodiversity.

In the Mediterranean, the Italian island of Sardinia is one of the regions with the highest biodiversity, especially in the flora. In the Northwest of Sardinia on the island Asinara (52 km^2) 700 plant species have been recorded. This high biodiversity is caused by a highly structured landscape like an undulating topography and coastal zones, corresponding different soil types, and, also, by a variety of grazing animals, e.g. horses, donkeys and mouflons, which have shaped the vegetation of the island of Asinara for centuries.

This project aims to investigate the interrelations between climate, soil, relief, grazing and biodiversity by studying the distribution of the main habitat types, the occurring soil types and their characteristics, the composition of the vegetation and their biological traits. Additionally, composition of ground beetle species of the different habitats is assessed and grazing animals are investigated regarding their preferences for grazing areas and fodder plants, the population sizes and the regulation of the livestock in the National Park are determined to evaluate the impact of grazing. Furthermore, the project aims to estimate how these interrelations could be affected by the climate change. The results of this project will establish a protection concept for the National Park of the island of Asinara.

P17 - Constraints of morpho-phenological and germination traits in the Mediterranean annual flora

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Reproduction via seeds is one of the key processes permitting populations to re-establish in their environment. However, the vulnerability of early stages of plant development especially germination make the germination timing at the right moment in the season particularly critical for seedling establishment. Annuals completely depend on regeneration by seeds, and are thus more constrained by environmental stresses during their life cycle and the need to produce seed in order to insure the new generation. Since annuals also can delay germination to other years, annuals are an interesting model system to study germination phenology, notably their response to temperature and moisture cues for germination.

Hydro-thermal time (HTT) models of germination using germination threshold values such as base temperature, base water potential and hydrothermal time, are well performing, population-based models capable to predict seed germination in the field. The critical threshold parameters of HTT models permit to use them to compare germination phenology among species. In the present work we focus on basal temperature (T_b) which is the minimum temperature below which germination cannot occur and its relations to other plant traits. Mediterranean eco-regions are characterized by a hot dry summer and moderately cold wet winter. Mediterranean annuals show a continuum between germination in autumn and flowering in spring and germination in spring and flower in summer resulting in contrasting HTT parameters. In a given climatic context, these key germination phenological parameters, are however, not independent from other plant characteristics, and constraints of plant traits on germination parameters are likely to occur.

In the present work we use an extensive data-set harvested by the French Mediterranean National Botanical Conservatory (Conservatoire Botanique National Méditerranéen, France) and HTT model published data from Mediterranean eco-regions to explore relations between plant traits and germination phenology. Especially, we test whether traits related to plant growth (*e.g.* RGR and SLA), size and flowering phenology are linked to basal temperature.

P18 - Development and standardisation of an ecotoxicological test method for the risk assessment of GMP

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Before a genetically modified plant (GMP) may be released into the environment and put on the market in the European Union (EU), an environmental risk assessment (ERA) according to EU directive 2001/18/EC must be performed. Currently, testing of effects of GMP on non-target organisms is based on ecotoxicological test methods developed for the assessment of chemicals. This does not comply with directive 2001/18/EC, which demands a case-specific ERA. According to Annex II of the directive a 'case' is defined as a combination of the parent organism, its genetic modification and the possible receiving environment related to the intended release and use of the GMP. As the standard test organisms used for the assessment of chemicals do usually not occur in the receiving environment of GMP, they cannot be considered adequate. According to an ecology-based selection approach test species should be selected from organism groups relevant to the receiving environment and to the various exposure pathways and that cover different taxonomical and physiological groups. Nevertheless, the use of test species needs to be practical for standardized testing in the laboratory. Hence, the aim of this R&D project (2012-2015) is the development and standardization of a laboratory ecotoxicological test especially for the ERA of GMP. This aim will be reached in three steps. First, the black fungus gnat *Bradysia difformis* Frey (Sciaridae: Diptera) was identified as a test species and its mass rearing in the laboratory was established. The second and currently ongoing work step comprises the actual development and trial of the test method that will meet the above mentioned characteristics of the assessment of GMP. In the third and final work step this method will be described in a draft guideline according to the specifications of the OECD or ISO.

P19 - EU BON - building the European gateway for integrated biodiversity information

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EU BON (2012–2017) stands for "Building the **Eu**ropean **B**iodiversity **O**bservation **N**etwork" and is a European research project, financed by the 7th EU framework programme for research and development. EUBON seeks ways for a better integration of biodiversity information and its implementation into policy and decision-making processes of biodiversity monitoring and management in the European Union. EU BON offers an innovative approach towards integration of biodiversity information systems from on-ground to remote sensing data, for addressing policy and information needs in a timely and customized manner.

EU BON will build on existing biodiversity data and observation systems, in particular GBIF, the emerging LifeWatch infrastructure, and national biodiversity data centers in Europe, as well as other environmental datasets and networks. These current systems are mostly unbalanced in coverage and not yet integrated, limiting integrative analyses and implementation of environmental policies.

To achieve this aim, a large collaborative network has been assembled (www.eubon.eu) with contributions from 30 partners including leading research institutions, small companies and NGOs from 15 European countries, Israel, Brazil and the Philippines and many associated institutions.

The main objective of EUBON is to follow the requirements set by Group on Earth Observation's Biodiversity Observation Network (GEO BON). Due to EU BON's contribution overall, European capacities and infrastructures for environmental information management will be strengthened.

P20 - Ecological impact assessment of alien species: generic and quantitative criteria

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The ecological impact assessment scheme that has been developed to classify alien species in Norway is presented. The underlying set of criteria enables a generic and semi-quantitative impact assessment of alien species. The criteria produce a classification of alien species that is testable, transparent and easily adjustable to novel evidence or environmental change. The impact of alien species is expressed along two independent axes, one quantifying invasion potential using three criteria, the other measuring ecological effects on native species and habitat types using six criteria. The set of criteria has been used to classify the 2320 alien species known to occur in Norway according to their ecological impact.

Session 27 - Soil food webs as drivers for soil function

Chair: Liliane Rueß

O1. - Nematological indices, microbial traits and interdependencies of soil C, N and P

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Trait-based indices have been widely applied to determine the below-ground effects of anthropogenic disturbances on the nematofauna. Given that the aggregation of the nematode community into one index value might result in difficulties in the interpretation of the signal, we investigated whether trait-based indices of nematodes are sensitive enough to assess the soil quality in agricultural soil systems. In the case of 137 locations in the Netherlands, we compared the suitability of indices to assess soil microbial and (a)biotic conditions for 6 combinations of management and soil type. Nematode abundance was strongly correlated with soil phosphorus (explained variances: 43.8 % for molar N : P ratio and 30.9 % for C : P ratio) and less with microbial biomass (explained variance 26.0 %). Generally, the nematode abundance reflected more the variances of abiotics and microbial parameters than trait-based indices did. Nematode maturity indices point to differences in management intensity between ecosystems, although maturity indices explained only a small fraction of the variance of soil parameters. For combinations of soil and management types, contrasting correlations between nematological indices and soil conditions were detected. Agricultural soils can be seen as characterized by a disturbance continuum and observed correlations were low as soon as soil and ecosystem types were analyzed together. Still, the gradients for soil abiotics and microbial parameters were rather large in comparison to single combinations of soil and ecosystem type. Dissimilarities indicate that small gradients within comparable ecosystems can largely hamper the interpretation of some indices and hence applying biodiversity indices to few locations in an attempt to assess the biological qualities at local scales should be performed with caution.

O2 - Complex bioindicator analysis to assess interrelations between microbial community and carbon pool dynamics

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Biomarkers are useful tools to characterize the microbial community or to distinguish organic carbon derived from plant, fungal, or bacterial sources. Due to their different characteristics regarding degradation/production within the soil system, a combined analysis of phospho- and neutral lipid fatty acids (PLFA, NLFA), amino acids, and carbohydrates allows bridging organic carbon transformation with changes in function and/or composition of the microbial community.

PLFA, NLFA, amino acids, monosaccharides, and amino sugars were determined together with SOC, total N, and labile OC and N. Soil samples were taken from the Static Fertilization Experiment Bad Lauchstädt. Unfertilized control and 5 different organic and mineral fertilization combinations were investigated from the alfalfa and sugar beet strips.

While the composition of the living bacterial community (PLFA indicators), varied only slightly under either crop, arbuscular mycorrhizal fungi (AMF) were significantly negatively influenced by mineral fertilizer under alfalfa. Relative to the microbial biomass, amino sugars were generally higher on the less fertilized treatments. A lower concentration of amino sugars was found in the control of alfalfa as compared to sugar beet. We hypothesize a mobilization of C and N stabilized in amino sugars by AMF. In the highest fertilization level of alfalfa considerable enrichments of monosaccharides and amino acids were found. It is notable that in both, control and highest fertilization of the alfalfa strip, the ratios of C6:C5 and deoxy C6:C5 of monosaccharides as well as the relative abundances of single amino acids imply a distinct microbial origin.

From our findings we conclude that (1) biomarker are related to SOC and labile OC reflecting short and long-term effects in C dynamics (2) in agricultural systems functional aspects, such as crop physiology and symbiotic interactions have a stronger influence on SOC dynamics than the composition of the microbial community.

O3 - Incorporation of 13C labelled glucose into soil microorganisms of grassland: effects of fertilizer addition and plant functional group composition

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In permanent grassland the influence of NPK fertilizer addition and sward composition (proportion of plant functional groups) on soil microorganisms and the incorporation of ^{13}C labelled glucose into microbial tissue were studied for one year. Microbial biomass was analysed by chloroform fumigation-extraction (CFE), soil microbial community structure by phospholipid fatty acids (PLFAs) and incorporation of labelled glucose into microorganisms by gas chromatography-combustion-isotope ratio mass spectrometry(GC-C-IRMS). PLFA biomarkers suggested that after two and six weeks fungi incorporated more glucose C per unit biomass than bacteria, indicating that fungi more quickly and more intensively capture glucose C than bacteria. While in fungi ^{13}C concentration decreased significantly after three month, in bacteria it remained at a similar level for one year, suggesting that microbial residues are processed predominantly by bacteria not by fungi. NPK fertilizer decreased soil microbial biomass and changed microbial community structure but did not affect the fungi-to-bacteria ratio.In fertilized swards the fungi-to-bacterial ^{13}C incorporation ratio increased, suggesting that NPK fertilizer addition increases the efficiency of resource capture by fungi. Sward composition little affected microbial community composition and glucose C incorporation.

Further the incorporation of glucose is traced into the mesofauna food web, namely collembolans and mites.

O4 - Translocation of plant carbon to different trophic levels in nematodes - a ^{14}C pulse-labeling experiment

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Rhizodeposits including root exudates are a plant carbon (C) source easily available and utilized directly by rhizosphere organisms. However, the importance of the rhizodeposit-C channel is often underestimated, likely because it is more difficult to study experimentally compared to the leaf litter channel. Thus, the knowledge of the contribution of C sources released by living roots to individual parts of the soil food web remains incomplete. We used the nematode community and their diverse trophic structure to assess the flux of C across different food web levels.

Maize was grown in a Luvisol, taken from an arable site, under controlled conditions in a climate chamber. Plants were pulse-labeled in a $^{14}CO_2$ atmosphere 28 days after germination. The ^{14}C activities of the bulk soil, rhizosphere soil, dissolved organic matter and microbial biomass, as well as of microbially respired $^{14}CO_2$ were considered as total rhizodeposition. The C-flux dynamics from roots to nematodes were assessed at day 2, 5, 10 and 16 after ^{14}C-labeling. Unplanted soil served as control. Nematode density generally increased during the 16 days experimental period. Nematode communities were dominated by plant feeders followed by bacterial feeders. The first generally showed the highest assimilation of plant C as assigned by ^{14}C . Incorporation of root C was also distinct in bacterial feeders, whereas fungal feeders and omnivores accumulated plant derived C to a much lower extend. The highest trophic level, the predators, lagged behind and was distinctly ^{14}C marked only at the end of the experiment after 16 days. In sum, root derived C was transferred across all trophic levels of the nematode food web, which underlines the importance of this energy and C channel for soil ecosystems.

O5 - Incorporation of root derived carbon and nitrogen into the soil animal food web of deciduous forests

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It is long known that soil organisms benefit from litter derived carbon, but the importance of root derived carbon has been underestimated for long. Carbon fixed by plants can enter the belowground system via roots and root exudates. Root exudates consist of low molecular carbon compounds, such as amino acids, sugars and peptides, and therefore are easier available for soil organisms then recalcitrant litter carbon. In addition to carbon plant nitrogen may also leak into the rhizosphere but this has not yet been shown for trees.

Soil organisms can be classified into primary decomposers feeding mainly on litter material, secondary decomposers feeding predominantly on fungi and microbial residues, and predators relying predominantly on secondary decomposers as food.

To investigate the incorporation of root derived carbon and nitrogen into the decomposer food web we established a pulse labeling experiment with tree seedlings of ash and beech in a plant growth chamber. Seedlings were labeled with $^{13}CO_2$ via the air and $^{15}NH_4Cl$ via the leaves. We followed the flux of carbon and nitrogen from aboveground to the rhizosphere and into the soil animal food web.

We hypothesized that ^{13}C and ^{15}N will be incorporated into soil organisms as carbon and nitrogen are translocated via roots and mycorrhiza into fungal feeding soil animals. Further, we hypothesized that by feeding on fungi secondary decomposer benefit from root derived carbon, while incorporation of the label into predators will be delayed and diluted. Primary decomposer are expected to incorporate little root derived carbon and nitrogen as they rely on litter and soil organic matter resources.

O6 - Multielemental stoichiometry of woodeaters and deadwood: the basic terrestrial trophic link depends on fungi.

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The stoichiometric transition between producers and herbivores is a challenge because of the mismatch between nutritional supply and demand. Dead plant matter alone can be unfit for consumption due to the high content of carbon and scarcity of other elements. To find out how xylophagous insects manage this drastic stoichiometric imbalance we compared element contents in the bodies of imagines and pupae of three species of wood-boring beetles: *Stictoleptura rubra*, *Arhopalus rusticus* (Coleoptera, Cerambycidae), *Chalcophora mariana* (Coleoptera, Buprestidae), with those of woody tissues (their potential food during larval development), from a life history perspective. Simultaneously we measured selected PLFA content as a proxy for fungal tissue content in the wood in order to examine if fungi may contribute to enrich dead plant matter in nutrients other than carbon. The imagines and pupae do not differ significantly from other Coleoptera in absolute element contents, but the ratios C:N, C:P, C:Cu, C:K and C:Na in the beetles are approximately $\times 10^3$ (N), $\times 10^2$ (P, Cu), and ×10 (K, Na) lower than in dead but undecayed pine wood, causing severe nutritional imbalance. Carbon loss from wood cannot explain the increase in the percentage of other elements, because their absolute content is increasing in dead wood during decomposition. Simultaneously increases the amount of fungal tissue presented in dead wood. Simulation of the life history of *S. rubra* shows that the beetle could not complete its life cycle depending on wood as the only source of nutrients. Fungal mycelium, covering large area of the forest, can transfer nutrients between soil and carbon-rich niches such as deadwood. Fungi play a pivotal role in nutrient cycling in the deadwood carbon-rich ecosystem and serve as nutrient delivers. This is the first attempt to study the essential macro- and microelement (C, N, P, K, Ca, Mg, Zn, Mn, Cu, Na) stoichiometric relations in a fundamental terrestrial trophic link.

O7 - Carbon flow in belowground food webs assessed by isotope tracers - FOR 918

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Soils store approximately 80% of global terrestrial carbon and small changes of fluxes into and out of this pool may influence the atmospheric CO_2 concentrations and interact with ongoing climate change. Considerable information is available on the total amounts, individual fractions and residence time of carbon in soil, but we lack sufficient inside in belowground trophic interactions that determine the critical balance between carbon mineralization and sequestration. The interdisciplinary Research Unit FOR 918 investigates belowground food webs using carbon stable isotopes to identify key groups of soil biota, quantify carbon fluxes, and establish food web models. The overall goal of the project is to understand the flow of carbon through biotic compartments within terrestrial ecosystems.

O8 - Effects of resource availability and quality on soil microorganisms and their Carbon assimilation

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In 2009, a C3-C4 exchange field experiment was established close to Göttingen (Lower Saxony, Germany) to analyse the carbon flow from different resources (maize litter and maize roots) into the belowground food web. We set up the following treatments: In the Corn maize plots the resources derived from roots as well as litter (C4 signal input by below- and aboveground sources). In the Fodder maize plots no litter was applied (C4 signal input by roots) whereas in the wheat + maize litter plots an additional resource was introduced by maize litter application (C4 signal input by aboveground sources). Plots which were cultivated with wheat served as the reference (no input of C4 signal).

Wheat cultivation resulted in higher abundance of microbial groups in comparison to maize and this was observed down to 50 cm depth. Litter application increased abundance of bacteria, fungi and hydrolytic enzymes only in the topsoil. The date of sampling (season) had a high impact on the analyzed parameters in all investigated depths (topsoil, rooted zone beneath the plough layer, unrooted zone) with increased amounts in winter, especially after snow cover. In the fungal biomass a higher enrichment with maize derived C was observed in contrast to bacteria. The assimilation of root and litter derived C in the topsoil was comparable within the considered groups.

O9 - Tracing keystone bacterial food web members in an arable soil: from SIP microcosms back to the field

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Belowground microorganisms play a key role in controlling carbon mineralization and sequestration in soil. In plant-influenced soils, microbial decomposers channel carbon resources derived from rhizospheric inputs or plant litter into the soil food web. Together with various predatory groups of soil fauna, soil microbes compose an intensely interactive system. Despite of the fundamental importance of soil bacteria as primary decomposers, they are poorly understood especially in terms of their identities, dynamics and specific activities in distinct carbon flows.

In FOR 918, we have identified distinct keystone bacterial constituents of the rhizosphere and detritusphere food channels in a maize field using rRNA-based stable isotope probing (SIP) in combination with pyrotag sequencing. Thus, key consumers of $^{13}CO_2$ pulse labeling-derived plant exudates were identified to belong to the *Alpha*-, *Beta*- and *Gammaproteobacteria* as well as *Planctomycetes*, *Sphingobacteria*, *Opitutae*, and *Actinobacteria*. The predominant *Bacteria* incorporating carbon from ^{13}C-labeled detritusphere substrates (glucose, cellulose, plant leaves and roots) were affiliated to the *Bacteroidetes*, *Actinobacteria*, *Beta*-, *Gamma*-, and *Deltaproteobacteria*.

Here, we trace these identified populations back to the field, to explore their distribution and abundance in distinct soil compartments and over seasons. In fact, identified keystone bacterial food web members were found to be of clearly elevated abundance at the root surface and in rhizospheric soil compared to bulk soil and deeper horizons. *Bacteria* that were pronouncedly labeled in rhizosphere were of highest abundance at the root surface in July (with highest root exudation), and those identified in substrate labeling experiments were most enriched in December on dead roots. Intriguingly, detrituspheric consumers appeared to be largely a subset of rhizospheric consumers in the field, thus challenging the current perception of both channels being isolated. Our results provide unique insight into discrete bacterial functions in a belowground food web and may allow for a more elaborate taxon-specific quantification of carbon fluxes through bacterial trophic links in the future.

O10 - Fungal community structure, distribution and food web members in an arable soil

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Due to their decomposition potential of organic materials, soil fungi play an essential role in the transfer of organic carbon from plant origin to belowground food webs. Compartments such as litter, rhizosphere and bulk soil represent soil organic carbon (SOM) pools with different quality and availability for fungal nutrition. The presented project used the field experiment of DFG research unit FOR 918 “Carbon flow in belowground food webs assessed by isotope tracers” to investigate how these SOM pools affect fungal communities in an arable soil. The experimental design cross combined treatments with 2 widely planted crop species, wheat and maize, and variable litter supply. In relation to the available plant derived resources along depth gradient and sampling season, we determined fungal community structure by using a molecular fingerprint technique (ARISA). Our results showed that fungal communities significantly varied between sampling date, soil depth and resource treatment and plant resources affected fungi down to the root free soil in 70 cm.

In addition, the project used a microcosm experiment with different highly ^{13}C-labeled nutrient supplies to follow carbon flux from plant-derived substrates into soil fungal communities and to identify carbon assimilating fungi as basal food web members. Using rRNA-based stable isotope probing (SIP) and a pyrosequencing approach it was possible to identify carbon assimilating fungi for all substrates and time points representing substrate degradation stages. Besides a succession in the fungal decomposition process, we could verify that fungal communities consuming carbon from labile substrate clearly differed from those consuming it from recalcitrant material.

Hence, the project gains insights into the impact of resource quality and availability on fungal communities and it links particular fungi to specific decomposition processes.

O11 - Nematodes in soil food webs varying in quality and availability of resources

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The dynamics of soil food webs are driven by inputs from plant resources, which vary in chemical composition and physical structure: one is litter, slowly decomposable plant material, the other is rhizodeposition, readily available carbon sources. At an arable site of a Luvisol soil type a field experiment was established in a stripe design. Treatments comprised corn maize, with harvest of corn cobs only, adding both litter and rhizodeposits to the soil, and fodder maize, where entire plant shoots are removed and only belowground carbon sources are supplied to the food web. To further investigate the role of shoot litter for soil animal food webs maize shoot litter was added to a wheat field. Nematodes can be used as entry-level indicators of such resource manipulations as they are involved in diverse trophic interactions. The nematode communities in a depth gradient from resource rich to deeper oligotrophe habitats, i.e. from high to low diverse food webs, were investigated in two successive vegetation periods. Crop plant (wheat *vs*. maize) did not significantly affect the density of nematodes, whereas litter application resulted in highest numbers under corn maize. In the plough layer the addition of maize shoot litter fostered bacterial and fungal feeders, in the rooted zone beneath plant feeders were beneficially affected by wheat as crop. Nematode community indices characterized the food web as nutrient enriched, with high degree of disturbance, and dominance of the bacterial energy channel. Overall, amendment with litter resulted in food webs that remained bottom heavy with only small amounts of carbon propagating to higher nematode trophic levels.

O12 - Carbon flow into soil animal food webs assessed by carbon stable isotopes

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The flux of carbon from plants into the soil animal food web is the most important transfer of energy in terrestrial ecosystems. Although soil animal species diversity and the connectivity between species determines the flux of carbon within the soil system and is of major importance determining the release or sequestration of carbon, surprisingly little is known on the spatiotemporal carbon dynamics in soil food webs. We followed the long-term and short-term flux of carbon into the soil animal food web of an agricultural field using pulse labelling experiments and natural ^{13}C stable isotope signatures after switching from C3 to C4 crop plants.

Unexpectedly, recently assimilated carbon was incorporated at a similar rate into soil animal decomposers and predators. Moreover, our results indicate that most soil arthropods rely on root-derived carbon resources, suggesting that soil food webs in arable systems are primarily fueled by the root-derived bacterial energy channel.

O13 - Above- and belowground carbon input drives energy fluxes in a complex soil food web

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As part of the Research Unit 918 „Carbon flow in below-ground food webs“ we analyzed carbon flows between different populations of soil organisms in agricultural fields. Storing ~ 80% of terrestrial carbon, soil is one of the largest natural carbon stores on our planet. Here, we use Bayesian approaches to predict how shifts in carbon flow within soil food webs alter CO2 release under different food web scenarios. We use biomass data of two different maize field treatments in order to evaluate effects of below- and above-ground carbon input on energy fluxes in soil food webs: (1) corn maize: maize litter remains on the field after harvesting; (2) fodder maize: maize litter is removed after harvesting. Due to these treatments we are able to distinguish between below- and above-ground carbon inputs. Our results give insight into the influence of carbon input on CO2 driving our climate. Atmospheric CO2 is known to be one of the most important greenhouse gases driving global warming. Therefore, basic knowledge on how carbon input may alter carbon flows in the soil and subsequently the CO2 storage and release capacities of soils is crucial for future global change predictions.

P1 - Ecological stoichiometry of xylophages. Changes in body elemental composition and nutritional demands during ontogenesis.

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The majority of terrestrial biomass is wood, but its potential consumers differ drastically in elemental composition what poses a challenge to their stoichiometric balance. We used two species of xylem-feeding beetles: *Stictoleptura rubra* (Coleoptera, Cerambycidae) and *Chalcophora mariana* (Coleoptera, Buprestidae) to learn how they can grow their tissues and match their life history to the dietary constraints. Percentage of carbon increases during larval development proportionally to the body mass, reaching maximum in the oldest larvae and pupae, and drops during eclosion. Other elements (P, K, Na, Ca, Mg, Zn, Fe, Mn) have tendency to decrease their relative values during larval development. N, P, Na, Ca, Zn and Cu are more concentrated in adult bodies than in the oldest larvae. Compared to body mass, elements other than C increase their concentrations at changing rates, two or more periods of different element deposition rates can be distinguished during larval development. N content (relative to body mass) increases slowly at the beginning, and faster during the final stages of development. Other elements show opposite tendency: their accumulation is faster at earlier stages of development. It suggests the N limitation during early growth period. The exceptions are: Cu in *S. rubra*, concentration of which drastically increases in the adults only, while K and Mg decrease their relative content during the whole development. Concentration of Ca increases rapidly in *Ch. mariana* adults. Relative to N the contents of P, K and Mg are lower, Cu is higher in *S. rubra* imagines than in its larvae. We measured elemental composition of wood inhabited by the larvae. The nutrients are initially scarce and their content (particularly of N) considerably increases during the first four years after tree cutting. Therefore, the dynamics of deadwood nutritional composition may affect the life histories of xylophages.

P2 - Multielemental stoichiometry of detritivory: the role of fungi

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The litter/soil invertebrate detritivores, such as diplopods or isopods, are believed to enhance the microbial decomposition of plant detritus and to facilitate element cycling in terrestrial ecosystems. On the other hand, the existing stoichiometric mismatch between detritivores and their potential food should cause a nutritional imbalance, thus negatively affecting this important trophic link. To get insight into this paradox we studied the changes in stoichiometry of decaying broadleaf and conifer litter, with regards to macro- and microelements (not studied before): C, N, P, K, Na, Ca, Mg, Cu, Zn, Fe, Mn. We found that most of the elements increase their concentrations more than it could be predicted from the amount of carbon respired by decomposers as CO_2. This suggests that the nutrient pool of decaying litter is enriched by elements imported from outside of this system, most plausibly by fungi. The analysis of PLFA composition in decomposing litters revealed that although broadleaf and conifer litters initially differ in fatty acid composition, the process of decomposition leads to their convergence, presumably due to the increasing contribution of fungal biomass. In effect, the stoichiometric threshold, initially impossible to surmount for detritivores, diminishes, although the nutritional imbalance between invertebrates and nutrient-enriched detritus may remain not fully compensated.

P3 - Decomposition patterns of undisturbed fine roots of temperate tree species

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Through their death and decomposition, plant roots can contribute considerably to biogeochemical cycles. Initial decomposition rates of intact root tissue to soil organic matter are affected by root structure and chemistry as well as complex interactions with the soil matrix. This study assessed root decomposition where disturbance of the soil matrix was minimized. We trenched minirhizotron tubes installed 5 years previously in monoculture plots of 10 temperature tree species at a common garden in southwest Poland to identify soil and plant variables that might influence root decomposition. Persistence of more than 900 served fine roots (< 1 mm) was tracked for almost 3 years. Artifacts common to root decomposition studies such as limited access of soil fauna, disturbance of the rhizosphere and large concentrations of root organic matter were thus avoided. By six weeks after the trenching, cross sections of severed roots stained with fluorescein diacetate showed no sign of root vitality in any tree species. Severed roots disappeared faster if new root growth had occurred nearby. Persistence of severed roots increased with soil depth, while increasing soil microbial biomass carbon, labile soil carbon content and earthworms decreased severed-root persistence, as did soil porosity and percent clay content. Severed older roots had higher root persistence than severed younger roots of the two maple tree species. Persistence of dead roots was relatively long in this sandy, infertile soil, ranging from 320 to greater than 974 days, depending on species. In conclusion, the minirhizotrons combined with trenching allowed for tracking the persistence of individual dead roots in an intact root-soil matrix. We found that several factors strongly influenced persistence, including soil depth, number of neighboring roots, and the abundance and activity of earthworms.

P4 - Mineralization rates of maize litter depend on a succession of protozoan grazers

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Decomposition of organic matter is crucial for ecosystem function. Microorganisms, which are responsible for the mineralization and recycling of nutrients required by plants, are usually treated as a homogeneous functional guild. However, there is strong evidence that microbes differ in mineralization capacity. In addition, a significant part of the microbial community in decomposing organic matter is top-down controlled by protozoan grazers. Since protozoan grazing is highly selective and selectivity differs among species, we hypothesised that protozoa specifically affect microbial decomposer diversity and function. We investigated the effects of protozoan diversity on the mineralization rate of maize litter in arable field soil by combining up to 6 protozoan species

from three functional groups: flagellates, ciliates and amoeba. “Diversity effects” of protozoa on overall mineralization were absent on the fresh decomposing plant litter, instead we observed a quick succession in dominance of different protozoan species. However, more specific grazing induced changes in microbial biomass and community composition partly depended on the diversity and functional composition of the grazers.

P5 - Quantification of rhizodeposition as primary carbon and energy source for soil microorganisms

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Rhizodeposition of plants is the most uncertain component of the carbon (C) cycle. By existing approaches the amount of rhizodeposition can only roughly be estimated since its persistence in soil is very short compared to other organic C pools. We suggest an approach to quantify rhizodeposition at the field scale by assuming a constant ratio between rhizodeposited-C to root-C.

Maize plants were pulse-labeled with $^{14}CO_2$ under controlled conditions and the soil $^{14}CO_2$ efflux was separated into root and rhizomicrobial respiration. The latter and the ^{14}C activity remaining in the soil corresponded to total rhizodeposition. By relating rhizodeposited-^{14}C to root-^{14}C a rhizodeposition-to-root ratio of 0.56 was calculated. This ratio was applied to the root biomass C measured in the field to estimate rhizodeposition under field conditions.

Maize allocated 298 kg C ha^{-1} as root-C and 166 kg C ha^{-1} as rhizodeposited-C belowground, 50% of which were recovered in the upper 10 cm. The fate of rhizodeposits was estimated based on the ^{14}C data, which showed that 62% of total rhizodeposition was mineralized within 16 days, 7% and 0.3% was incorporated into microbial biomass and DOC, respectively, and 31% was recovered in the soil.

We conclude that the present approach allows for an improved estimation of total rhizodeposition, since it accounts not only for the fraction of rhizodeposits remaining in soil, but also for that decomposed by microorganisms and released from the soil as CO_2.

P6 - Carbon flow via the herbivore and detritivore food chain in an arable ecosystem

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In the frame of the DFG-Project (FOR 918) “Carbon flow in belowground food webs assessed by isotope tracers“ we followed the input of carbon into the soil microbial community of an arable ecosystem. A field experiment was established in 2012 near Göttingen (Lower Saxony, Germany). Three treatments were used to follow the carbon flow separately through the herbivore and detritivore food chain under field conditions: The maize plant treatment provides C from the roots, the maize litter treatment serves more recalcitrant material to the soil and a fallow treatment was used as control (no maize carbon input). Soil samples were taken three times a year in July, September and December and were analyzed for microbial biomass, phospholipid fatty acids (PLFAs) and ergosterol content as a biomarker for fungi. The incorporation of maize-derived C into the different microbial pools was analyzed by measuring $\delta^{13}C$. Total microbial biomass measured by the chloroform fumigation extraction method (CFE) did not differ between treatments in July, September and December 2012. Nevertheless, component specific analyses of the fungal biomarker ergosterol showed that the litter treatment stimulated fungal growth to a higher extend than the plant treatment. The determination of the incorporation of maize-derived C into microbial biomass and into PLFAs is still under way. We hypothesize the increase of maize-derived C in these pools will be faster through the herbivore than through the detritivore food chain.

P7 - Allometric scaling of soil food webs forecasts biotic interactions and trait-based ecosystem functioning

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Plant traits have been widely used to evaluate ecosystem functioning but there are few examples of trait-based approaches to assess soil ecological processes. Recent studies on soil biota showed that species’ numerical abundances and body-mass averages are functional trait proxies for ecosystem structure (Mulder et al., Adv. Ecol. Res. 2011, 2012). The exploration of changes in the faunal body-mass distribution under different environmental conditions allows the identification of trait-mediated belowground responses to aboveground pressure. Allometry as such can thus be used as an integrated measure for the anthropogenic influence on soil food webs (Mulder and Elser, Global Change Biol. 2009). To validate this approach at local scale, we selected a former organic, currently abandoned, grassland as a reference for an undisturbed soil community. We investigated the organisms belonging to bacteria, fungi, protozoans, nematodes, micro-arthropods and oligochaetes from both a taxonomic and a functional perspective. In contrast to previous studies, amoebae and flagellates were included. Protozoans perfectly filled the gap of five orders of magnitude between the body masses of nematodes and bacterial cells, with significantly constant scaling coefficients at both taxonomical and functional levels. After plotting functional groups and operational taxonomic units (OTUs) into a body mass - numerical abundance log-log plane, we saw the universal 3/4 scaling confirmed regardless of data lumping or chosen species combination.

Session 28 – Management of ecological data through its life cycle

Chairs: Michael Owonibi, Sophia Ratcliffe, Jie Zhang

O1 - Ecological data management through its life cycle

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Research in the biodiversity and ecological sciences nowadays produces a massive amount of data which continues to rise exponentially. Science and society require unprecedented access to ecological data across difference spatial and temporal scales, which necessitates the efficient management of ecological data throughout its life cycle. Nevertheless, the principal challenges lie in the lack of data management knowledge (such as metadata standards, data repositories, data versioning, and data citation and publication) among researchers. To address these problems, various research projects have developed data platforms with their own generic data management solutions. However, these E-solutions are seldom acknowledged, compared, linked, or reused because they are usually specifically targeted to certain projects with limited funding periods.

This paper proposes a three-layer architecture for long-term data management within the ecological society of Germany. It includes individual researchers' database, project related data platforms, and long-term funded international data centers or cyberinfrastructures. This architecture guarantees: (1) education and consulting of data management for ecological researchers (2) collection and networking of available data platforms with function and architecture reuse (3) long term data curation, preservation and citation. The KiLi database (DFG FOR1246 Kilimanjaro ecosystem under global change: www.kilimanjaro.biozentrum.uni-wuerzburg.de) is presented as a successful example of architecture reuse. Current and future challenges from both technical and social perspective, such as procedures for database transformation and data sharing policy, will be presented.

O2 - Integrating data publishing with workflows in biodiversity research

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The Biodiversity Data Journal (BDJ) (www.pensoft.net/journals/bdj) and the associated Pensoft Writing Tool (PWT) (www.pwt.pensoft.net) support the full life cycle of a manuscript - from writing through submission, peer review, publication and dissemination - within a single, fully XML-based, collaborative online platform.

BDJ publishes papers in all branches of biodiversity science, e.g. ecological or environmental data, floristic/faunistic, morphological, genomic, phylogenetic, taxonomic, with no limit to manuscript size. The main manuscript types are: (1) ecological and biological observations of species and communities; (2) data papers describing biodiversity-related databases; (3) sampling reports and local observations; (4) local/regional and/or habitat-based checklists/inventories; (5) taxon treatments (6) identification keys, from conventional dichotomous to multi-access interactive keys; and (7) descriptions of biodiversity-related software tools.

Submissions to BDJ are formally peer-reviewed and evaluated for technical soundness and the correct presentation of appropriate and sufficient metadata. The scientific quality and importance of paper and data will be judged by the scientific community through a community-based pre-publication peer review and possibilities to comment after publication (post-publication peer review). Authors can opt for an entirely public peer-review process, reviewers whether to be anonymous or not.

To keep costs affordable, submissions through PWT are structured and compliant to biodiversity standards like the Ecological Metadata Language (EML). Manuscripts can also be submitted from external platforms like Scratchpads or GBIF's Integrated Publishing Toolkit (IPT). The PWT provides a set of flexibly pre-defined article templates, standard word processing functions as well as search and import functions, e.g. for external databases, electronic registries, occurrence data in Darwin Core format, or reference bibliographies.

O3 - BEFdata - an online collaboration tool for primary data, metadata and naming conventions in ecology

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Data management tools are essential for research consortiums to efficiently manage data sharing and synthesis between the collaborating groups. BEFdata is an open-source data management tool that allows scientists to upload, store and validate data in a secure environment. The portal was developed within the Biodiversity-Ecosystem Functioning (BEF-China) research unit of the German Science Foundation (FOR 891).

FunDivEUROPE, a European-wide research consortium of 24 institutions, adopted and joined the development of BEFdata to harness its dataset validation and harmonisation capabilities. We present the functionality in BEFdata that has enabled FunDivEurope to achieve consistent datasets across working groups, facilitating synthesis and meta-analysis at the level of the primary data.

The key features are: metadata and primary data are uploaded via an MS Excel workbook, ensuring that metadata and data ownership are preserved with the data; during upload data is harmonised and validated against existing naming conventions, facilitating standardised and consistent datasets; data owners and managers can edit metadata and naming conventions online using simple and intuitive admin pages and replace the data at any time; and scientists, with sufficient access rights, can download datasets in the original MS Excel format or as text files, and can also import datasets directly into R, supporting data sharing and pre-synthesis data preparation.

O4 - R-BEFdata, a package for analysing data stored on a BEFdata portal

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In ecology, small and complex datasets contributed from a wide range of disciplines are combined to answer interlinked questions, ranging from genes to the biosphere. Workflow software packages gained popularity over the last decade that support researchers to deal with this complexity. On one hand they provide an intuitive way to communicate ongoing analyses and on the other hand they support provenance tracking of final research results.

We here present the BEFdata R-package that combines the strengths of the BEFdata portal in handling and describing small, complex datasets with the powerful statistics package R. The combination enables researchers in a project to store, describe and access their data. The package supports the access to datasets as well as to metadata and workflows in form of R scripts which is useful for provenance tracking of computed results.

The package is open source an can be found on Github (https://github.com/befdata/rbefdata). The latest stable version is installable via the R command install.packages(“rbefdata”) directly from the Cran repository.

O5 - BEXIS - supporting integrated data management through the entire ecological data-life-cycle

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Developing efficient tools to manage the entire ecological data-life-cycle has been a challenge and an active research field in applied computer science for more than a decade. Specialized tools to handle different components of the data-life-cycle including data processing, analysis, and data storage are present in diverse forms. However, the availability of frameworks connecting different components of the ecological data-life-cycle is limited, thus hampering efficient integrated data management.

In this presentation we will illustrate how challenges in data management and data-life-cycle are being addressed during the development of the new BEXIS 2.x.x software. The Biodiversity Exploratories Information System (BExIS) has been established as a data repository and information exchange platform of the Biodiversity Exploratories project. The BExIS System has also been instantiated and adapted by additional projects such as the Jena Experiment, Kilimanjaro, and EFForTS. As part of the DFG-LIS funded project BExIS++ (http://fusion.cs.uni-jena.de/bexis) the system is currently being refactored and redesigned to meet the demand for a more generic, scalable, modular and interoperable software. Following the data-life-cycle concept the new BEXIS 2.x.x software will provide modules for data collection, discovery, dissemination, integration, quality assurance and research planning. A second release is scheduled to be published under a GNU General Public License version 3 in September 2013.

O6 - The Jena Experiment Information System - an infrastructure to enable data synthesis in a long-term biodiversity project

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The Jena Experiment (www.the-jena-experiment.de) is a biodiversity research unit, which is funded by the Deutsche Forschungsgemeinschaft (DFG) since 2002. With a project duration of more than 10 years, it is the longest running biodiversity experiment in Europe. At the 10 ha field site located near the Saale river in Jena, Germany, plant diversity is deliberately manipulated in order to study biodiversity effects on a wide range of different ecosystem properties and functions. The main goal is a full quantification of the most important element cycles as well as a coordinated investigation of aboveground and belowground processes, which will be used to unravel the mechanisms underlying the observed biodiversity effects.

For this purpose, the field site is divided into more than 400 research plots, which differ in size and treatment as well as composition of plant species and functional groups. There are more than 10 additional experiments nested within these plots. In the first years, the emphasis was on the collection and storage of data. Until now, about 14,000 individual variables have been measured along the experimental plant species richness gradients. Because of the high amount of available data, the focus has shifted towards more complex questions requiring long term data series and the synthesis of various different processes. This shift in research questions also required new approaches in data management, because individual variables rather than datasets need to be searched and collated for this kind of analysis.

In this talk we outline how the transition from a dataset storing platform to a more synthesis based information system was made. This transition was necessary in order to be able to build classifiers derived from different metadata information, e.g. treatment of the plots, layer of the measurement and so on. We present solutions for data acquisition, metadata management and reuse of data which we have implemented in BExIS, a platform for biodiversity information systems. We believe that the approaches developed are of interest beyond the concrete technical realization and are useful for similar projects.

O7 - Annotating biodiversity data - the AnnoSys Approach

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For more than a decade, international initiatives such as the Global Biodiversity Information Facility (GBIF) are providing open access infrastructures to connect biodiversity data from various distributed sources. Currently, about 40% of the 390 million primary biodiversity data records provided by GBIF are based on specimens. Traditionally, specimens are annotated in written form and the annotations are added directly to the specimens. Annotations, e.g. concerning the taxonomic identity of a specimen, are an important quality control mechanism that improves the scientific value of the specimens for further research. However, with specimen information increasingly available and used on-line, the traditional flow of annotation information is becoming interrupted, because it lacks a mechanism for on-line users to add annotations to digital records of specimens and to report them back to the original source and to the community. A general online annotation system ensuring data sharing and documentation of specimen data after the information is mobilized by digitisation is needed.

AnnoSys develops an annotation data repository for networked and highly complex biodiversity data available via the Internet. Our prototype is based on the XML-standards ABCD and DwC and uses the RDF-based W3C Open Annotation Data Model to store and exchange annotations, thus making it highly interoperable and flexible. AnnoSys provides a user interface which allows users to annotate digital records and to search for annotations using specific criteria. The repository persistently saves all annotations together with the original record the annotation refers to, allowing the comparison between original and annotated record. A message system notifies data providers and subscribed users about new annotations concerning their area of interest. A security component is responsible for the administration of user accounts, including secure user authentication, authorisation and access rights management.

The focus of the prototype is on collection data in the botanic domain provided by the GBIF/BioCASe system, however, the use of largely generic software allows an expansion to other disciplines that are using XML-based standards for data exchange.

O8 - Data at risk of getting lost: the reBiND project provides software to rescue, archive and share biodiversity data

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Data generated in studies and smaller projects are often not integrated into institutional data curation processes but stay with the authors on their own data storage systems, often on personal computers. The researchers mostly don't have the capacity to ensure the long-term availability of their primary research data. Since only a part of these data are available in publications, the rest of the raw data are at risk of becoming outdated. These data however could be of great value for the scientific community and should be made accessible and shared for re-use.

This is why the reBiND project (http://rebind.bgbm.org), funded by the Deutsche Forschungsgemeinschaft (German research foundation) started. The reBiND team develops a workflow to simplify data rescue. It combines software tools for transforming outdated database systems into well-documented, standardized and commonly used XML formats, like ABCD (Access to Biological Collection Data) with a system for storing, documenting, and publishing the information as web service. The software includes data correction, a review interface, metadata storage using the EML format (Ecological Metadata Language) and an API for making the data retrievable. The data will be connected to the Global Biodiversity Information Facility (GBIF) and BioCASE.

P1 - Biodiversity data at risk: Safeguarding and publishing the data as a joint effort of reBiND and GBIF Germany

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The Global Biodiversity Information Facility (GBIF) is an international network providing open access to primary biodiversity data about occurrence of organisms over time and across the planet. Currently, about 5 million botanical records are made available via GBIF Germany (www.gbif.de).

However, many digitised but unpublished data remain invisible, especially if they are not accessible through data repositories or collection databases. Usually, only a small part of the raw data generated by scientists or projects is used in publications and thereby made available for the scientific community. The majority of valuable primary biodiversity data is locked up in unpublished files, saved in undocumented file formats and/or stored on media quickly becoming outdated. Thus, these data are in danger of being lost for the scientific community.

For this reason the reBiND project (http://rebind.bgbm.org), funded by the German Research Foundation (DFG), establishes an archive to rescue such endangered data. In the reBiND workflow source data are transformed into standardised and commonly understood XML formats (e.g. ABCD) and passed through a quality checking process.

In cooperation with GBIF Germany these data are made publicly available to the global GBIF network via an interface. Thus providing access to almost lost but urgently needed scientific data. The presented case studies using environmental or ecologically relevant data demonstrate the GBIF-reBiND cooperation.

P2 - Improving quality of metadata in biodiversity databases - A proposal for a workflow of quality-assurance

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There are an increasing number of biodiversity experiments with an exponentially growing number of data and metadata. While projects have different technical solutions how to save data (e.g. , web based platforms like BExIS or FOR816dw, Lotz et al. 2012) they all use a similar workflow: (i) a field worker plans data collection (i.e., prepares metadata), (ii) collects data and (iii) stores data in central platforms (e.g., by online upload).

Typically, within the projects, data managers provide the technical utilities and guidance which information has to be given to the database. Authors of data have to give full descriptions of their data (i.e. metadata, e.g., about persons involved, dates, methods, measured parameters, keywords). A good metadata description ensures that the data are usable for long term research. Whilst some data can be checked automatically (e.g., by outlier analysis, classifiers, plot codes, species names), this is typically not possible for the scientific quality of the metadata provided. Here, currently, one has to rely on the authors of data. In most projects, the data managers do not possess sufficient knowledge about all subdisciplines involved, to do meaningful, comprehensive manual checks of metadata quality. We therefore focus on the problem of metadata preparation, e.g., on avoiding errors in documentation or uninformative content in descriptions.

We here discuss how to modify the workflow in biodiversity data platforms in order to improve the quality in metadata description. We propose to include reviewing steps during data upload that involve data submission, review by referees or editors, adaptations to the metadata, and final approval by data management. Metadata could, for example, be checked by two other members of a research consortium to provide suggestions for improvement of data description. Such a review of metadata would identify potential mistakes and improve overall readability of descriptions to people not directly involved in the collection of the specific data. This strategy requires some changes in views, editorial and technical controls in the programming environment of online platforms. We think that the implementation of a review process for metadata is worthwhile and also of interest for other biodiversity data base projects and will improve data use and accelerate the data publication processes (Costello et al. 2012).

References:

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P3 - GeoNetwork: An established platform suitable for data management in research projects?

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Central data management is of particular importance to joint research projects, because of their interdisciplinary nature, often large and high amount of datasets and consequential need for reliable data exchange. Since project members are often distributed across different locations, but their success depends on a consistent and easy exchange of data, data repositories are often web-based.

The number of data infrastructures will grow considerably in the future, among other things because of the European INSPIRE Directive and the requirements for research projects to consider the realm of data management more closely, e.g. enforced by the German Research Foundation. A standard-compliant and customizable Open Source solution will help to implement data infrastructures faster and to avoid unnecessary in-house developments.

Sustainable data management does not only include the long term preservation of data but also guarantees the continued maintenance, support, and further development of the infrastructure itself. Open source applications offer the advantage to build upon proven software components from previous projects and to pass on own enhancements. Established and well-documented solutions such as GeoNetwork opensource or the Comprehensive Knowledge Archive Network (CKAN) could form the basis for data repositories. Both platforms are widely used for governmental data portals, but are also in use as central data repositories for a number of joint research projects.

We would like to present experiences gained from the use of GeoNetwork opensource in joint research projects confirming that the software meets the requirements for data management and is flexible enough for customization. Such well established platforms facilitate the sustainable exchange of data across different projects (harvesting) and a straightforward maintenance and development even after changes in staff.

Session 29 - Ecohydrology of Drylands - Recent insights, perspectives and challenges

Chairs: Katja Geißler, Anja Linstädter, Jan C. Ruppert

O1 - Impact of feedbacks between vegetation pattern and ecosystem functioning in the response of drylands to external stress

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Despite the increasing interest in the feedbacks between vegetation pattern and ecosystem functioning in drylands, modeling and field studies testing or quantifying the underlying key assumptions driving these relationships are very scarce. In this study, we used a modeling approach to represent feedbacks between vegetation pattern and ecosystem functioning driven by the connectivity of runoff-source areas (e.g., bare soils) and to investigate the impact of various feedback strengths on the response of the ecosystem to changing climate and human pressure. In general, the connectivity-mediated feedbacks decrease the amount of pressure required to cause a critical shift to a degraded state and increase the pressure release needed to achieve the ecosystem recovery. The impact of these feedbacks is markedly non-linear, which is linked to the also non-linear increase in bare-soil hydrological connectivity with decreasing vegetation cover. Modeling studies on dryland vegetation dynamics not accounting for the connectivity-mediated feedbacks studied here may underestimate the risk of critical shifts from vegetated to degraded states in response to external stress. Our results also suggest that the acceleration of bare-soil hydrological connectivity from spatially-explicit time-series data may provide an early warning of imminent shift.

O2 - Savanna or Grassland - Which biome is more resilient to anomalies in precipitation? A data-fusion study in arid and semi-arid Africa

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Climate Change is assumed to alter temperature and precipitation patterns throughout (semi-) arid Africa and to even increase the already high climatic variability which is characteristic for drylands. Projections indicate an increase in temperature and in intra- and interannual variability of rainfall, leading to erratic switches between high and low rainfall years. Savanna and grassland biomes represent the majority of terrestrial ecosystems in Sub-Saharan Africa. The two biomes are assumed

to differ in their buffering capacity for rainfall variability including extreme events such as droughts. Besides biome type, grazing intensity also seems to play a crucial role for vegetation resilience to drought.

Our study aims to assess the resilience of savanna and grassland vegetation to droughts, comparing monitoring data from sites with different grazing intensities. We analyze 11 long-term plant productivity studies from Sub-Sahara Africa (7 savanna and 4 grassland studies). Aboveground net primary production (ANPP) and rain-use efficiency (RUE; ANPP/annual precipitation) are used as proxy for vegetation performance. We evaluate vegetation response to droughts in the past decades with respect to two aspects of resilience, i.e. drought resistance and recovery. We define resistance as the reciprocal difference in ANPP and RUE between drought years and the average of years with average rainfall. Similarly, recovery is tested as differences in ANPP and RUE between drought and post-drought years.

From preliminary and published studies, we know that the grassland and savanna biome show distinct responses to precipitation and precipitation anomalies. The coupling between productivity and precipitation is stronger in grasslands as compared to savanna systems (Ruppert *et al.* 2012). At the same time grassland sites are also more resilient to precipitation anomalies, while savanna sites are more prone to degradation via bush encroachment and/or erosion. By improving the understanding of the role of rainfall anomalies, and specifically its interference with grazing intensity, in savanna and grassland systems, this study might help adapting the right management strategies to climate change.

O3 - The role of a water dependent bottleneck in semi-arid savannas response to Climate Change

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Semi-arid and arid savannas exhibit non-linear responses to land use and climatic variations in form of losses in vegetation cover and/or changes in vegetation composition with negative consequences for biodiversity, water retention, soil protection and biomass provision. Recent studies come to different conclusions with regard to the future dynamics of dryland ecosystems under livestock grazing, altered climatic conditions and increased levels of atmospheric CO_2. At this, several studies predict increased levels of shrub encroachment due to positive effects of CO_2 fertilization, which is assumed to favour C3 shrubs over C4 grasses.

We enhanced and parameterized an eco-hydrological savanna model to assess the impacts of a range of climate change scenarios on the response of a semi-arid African savanna to grazing. We focused on the effects of temperature and CO2-level increase in combination with changes in inter-and intra-annual precipitation patterns on the long-term dynamics of soil-water in two soil layers and the respective dynamics of the three major plant functional types.

Our study revealed that the response of savanna vegetation to changes in temperature, precipitation pattern and atmospheric CO2 under different scenarios of livestock grazing is strongly determined by the demographic bottlenecks of woody plants at seedling establishment. The latter is strongly limited by soil-water availability and its inter-annual dynamics. Interestingly and in contrast to other recent studies, our simulations do not predict increased levels of woody plant encroachment under future conditions, as increased evaporation due to rising mean temperature narrows the abovementioned recruitment bottleneck. In addition, we found that the capacity of the savanna to sustain livestock production depends on the amount and temporal distribution of precipitation. Negative effects of rising mean temperatures are potentially (over-) compensated by the resulting future dynamics of rainfall.

O4 - An ecohydrological perspective on shrub encroachment: plant traits across species and degradation gradients in a semiarid African savanna

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Shrub encroachment is considered as the most threatening form of land degradation in African savannas. The key drivers are highly unpredictable climatic conditions and unsustainable livestock management, which affect ecological and eco-hydrological processes responsible for germination, establishment, growth and mortality of plants. The main objectives of our study were to reveal causes and consequences of shrub encroachment from an eco-hydrological perspective and to obtain reliable relationships between habitat and vegetation characteristics. From a plants perspective, a promising approach is the use of traits that are associated with higher competitive ability related to water. This seems especially important in the light of savanna degradation for which several studies indicate that rarely occurring climatic conditions like droughts or series of good rainfall years trigger the dieback of desirable grasses or facilitate mass recruitment events of encroacher species, respectively. Other traits comprise the ability of different plant types to withstand environmental extremes like droughts and to recover from them. The variability of the recovery potential of structurally important savanna plant species and the influence of soil characteristics modified by land use are still widely unknown.

In this study, which has been conducted along degradation gradients in the Kalahari savanna rangeland of the Omaheke region in Namibia, the clarification of plant strategic trait variation across species and sites regarding the water limitation factor and spatio-seasonal variation in soil, grass and shrub water status will be linked to the understanding of the main selective forces that shape semiarid savanna plant communities.

O5 - Canopy density of four *Acacia* species modulates their facilitative effects in an Ethiopian savanna

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In xeric savannas, isolated trees typically facilitate plant growth in their sub-canopy habitats, mainly due to an alteration of eco-hydrological processes, with these effects being more pronounced under conditions of higher climatic aridity. Along a regional gradient of climatic aridity in southern Ethiopia, we evaluated canopy effects of three native invasive *Acacia* species (*A. drepanolobium, A. seyal, A. bussei*) and a non-invasive species (*A. tortilis*) on the herbaceous vegetation. We assumed that total and forb biomass, species richness and diversity would increase in sub-canopy compared to inter-canopy habitats, with more pronounced differences in a climatically more arid landscape position. Species with an intermediate canopy density were assumed to be most facilitative. We collected local ecological knowledge of Borana pastoralists to assess species-specific differences in invasiveness and canopy density. We then applied linear mixed-effect models to examine the influence of landscape position (lowland or upland), *Acacia* species, and habitat (sub-canopy or inter-canopy), and their interactions on herbaceous vegetation. Differences in plant community composition were evaluated with NMDS. We found significantly higher forb biomass and species diversity, and lower grass biomass in sub-canopy habitats. As assumed, strongest canopy effects on community composition were observed for a species with an intermediate canopy density (*Acacia bussei)*, which also increased diversity up to 32% and total biomass up to 29% compared to inter-canopy habitats. The open canopies of *A. drepanolobium* and *A. seyal* exerted non-significant effects. Surprisingly, stronger overall and species-specific canopy effects were observed in the less arid upland environments, probably due to a redistribution of water within the landscape. Our study provides new insights why native invasive *Acacia* species have detrimental effects on ecosystem services of arid rangelands. In addition to negative landscape-scale effects which could outweigh positive effects at the local scale, the open canopies of highly invasive *Acacia* species are also comparatively non-facilitative.

O6 - Dynamics of plant diversity along environmental gradients over nine years in an arid mountain ecosystem

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The relationship between plant diversity and environmental gradients has been studied extensively the last decades. However, temporal changes of species richness over long environmental gradients have normally been neglected. Further, it remains unclear to which extent climate or land management affects plant abundance and diversity particularly along arid altitudinal gradients. In order to better understand the impact of climate and grazing on vegetation, we monitored plant abundance and diversity with an exclosure experiment at ten different locations with a total of 35 plots from 2001 until 2010 along an altitudinal gradient of about 3.000 m in arid to semi-arid southern Morocco. At the ten locations, we installed permanent plots inside and outside of a fence and visited these each year. We counted plant individuals in 100m² plots within a 0.25 m² grid. Each location was equipped with a meteorological station supporting mean daily values for certain weather parameters. The resulting spatio-temporal dataset was analyzed with Generalized Additive Mixed Model (GAMM) regarding the effects of temperature, precipitation and humidity, grazing, time, bioclimatic unit on plant diversity, plant biomass as well as life-form abundance. We found a continous increase of species richness at nearly all locations except of the Saharan plots over the nine years. However, grazing did not show a clear impact on species richness. Further, we found biome specific nonlinear-responses of richness and frequency at species and life-form level. The increase in species richness is interpreted to be a recovery from a previous drought period ending at the year 2000.

O7 - Phreatophytes - plants of arid regions between ground water and atmosphere

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Phreatophytes are plants with temporary or permanent access to ground water. Thus, they constitute "adjustable connecting pipes" between the ground water and the atmosphere. They are widespread in arid and semi-arid regions and occur along streams, on floodplains, in grassland and deserts (including oases) and in dry shrub- and woodland, but also on coastal sand dunes. The presentation will provide an overview of shared morphological, anatomical and physiological traits of phreatophytic plants on the basis of selected examples. It will show that phreatophytes are adapted to the high transpirational demand at the typical sites of their occurrence through rapid vertical root growth and high hydraulic conductance of roots and shoots, and that species-specific factor combinations are effective in the regulation of the transpiration. It will also demonstrate that phreatophytic vegetation often displays vigorous vegetative regeneration and can attain high rates of biomass production, but also transpires large amounts of water, which often results in a low water use efficiency related to the biomass of above-ground plant parts. Phreatophytes also play a substantial role for the structure of ecosystems and landscapes, and can be used for monitoring and

in landscape management. In subdividing phreatophytes according to their dependence on ground water, it is suggested to replace the conventional term "obligate" with "permanent", and "facultative" with "temporary" as the fraction of the water demand that is covered by uptake of ground water seems to be determined by environmental conditions rather than by inherent traits of the plants.

O8 - Modelling current and future land use in Mkomazi River Basin

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Global climate change may decrease availability or shift seasonal allocation of fresh water resources water in many dryland areas. This is a critical development, since the distribution of vegetation and corresponding land use practices in drylands is mostly governed by water resources.

We studied the relationship between water availability, vegetation and land use in the northern Mkomazi River Basin, a large semi-arid valley surrounded by the South Pare and West Usambara Mountains in north-eastern Tanzania. We analyzed soil, vegetation, plant trait, disturbance and hydrological conditions for a wide range of vegetation and land use units in the basin. Our aim is to predict future changes of vegetation and land use distribution in the basin due to alterations of water availability.

In a first step, multi-variate statistics and a GIS database were used to model correlations between pedo-hydrological conditions and land use in the research area. The model was utilized to predict future land use distribution, based on scenarios for hydrological conditions under climate change.

Our model shows that land use distribution in the northern Mkomazi River Basin is strongly correlated to water availability. On the valley bottom, the only sites suitable for productive farming were local water sources, whereas the dry plain is mostly used as grazing ground. Integration of climate change scenarios into the model indicate a decreasing spatial and temporal extension of local water sources in the valley which will result in land-use shifts from irrigation and rain-fed farming to grazing. If unattended this will lead to reduced agricultural productivity and environmental degradation, both serious threats for the livelihood of the local communities.

P1 - Simulating soil water and vegetation dynamics on the Qinghai-Tibetan Plateau: How does climate change influence alpine ecosystems?

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The contemporary alpine ecosystem of the entire Tibetan Plateau (TiP) is mainly covered by grasslands. Throughout the early to mid-Holocene the lands were largely forested. However, analyses of pollen records suggest a dramatic and extensive forest decline beginning in mid-Holocene, around 6000 years BP. It is widely accepted that a change in regional climate conditions had a significant impact. Many studies have however questioned whether or not climate alone was the main controlling factor for this decline. It still remains unclear, if and to what extent human activities were also involved. In this context it is relevant to note that currently anthropogenic impacts (overgrazing, land management) as well as climate change and their interaction cause a high degradation of alpine grasslands. Consequences comprise significant changes in vegetation composition, less productivity, loss in soil nutrients and water conservation capacity up to severe desertification effects.

To understand the nature of tree decline on alpine meadows in the north-eastern TiP during the Holocene we used a modelling approach. Since there can be potentially low amounts of precipitation we studied the vegetation dynamics with a process-based ecohydrological model which has been recently developed for drylands (Tietjen *et al.* 2010). In a first step, we successfully adapted the existing grid-based vegetation model to an alpine meadow in the north-eastern TiP. Simulated time series data for soil moisture and vegetation coverage fit empirical recorded data rather well. By comparing pollen patterns with simulated vegetation pattern based on pollen independent climate data, we will be able to test to what extent past climate change impacted forest decline. If we assume that the recently observed trend of increasing temperature remains, we could further assess how current climate change will affect future soil water and vegetation dynamics on alpine meadows.

P2 - Integrating complexity in an ecohydrological model - lessons from the separation of evaporation and transpiration in a savanna model

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Drylands are characterized by a low ratio of annual rainfall to potential evapotranspiration and a strong coupling of water and vegetation dynamics. Because of the limitation in water availability, it is crucial to understand how much of the soil water is actually available for plant growth and maintenance of stand biomass, and how much is lost by evaporation or other water fluxes. However, simplified ecohydrological models in drylands traditionally summarize water losses to the atmosphere by a term describing joint evapotranspiration, which does not allow for explicitly assessing the water flux through plants and thus for directly calculating plant growth.

We therefore extended the ecohydrological drylands model EcoHyD of intermediate complexity by a more detailed description of the separation between evaporation and transpiration and assessed the impact of this separation on plant performance. EcoHyD describes water dynamics of surface water and water distribution in two soil layers as well as vegetation dynamics of three plant functional types (PFTs), namely perennial and annual grasses and woody vegetation. For each PFT we explicitly linked actual transpiration to its cover, root distribution, water uptake rate and competition to other plants.

We applied the model to a semi-arid savanna in Southern Africa and assessed the impact of separation of evaporation and transpiration on water fluxes and on the performance of the PFTs under different climate scenarios. The results allow us to draw conclusions under which settings specific model complexity is needed and when simplified descriptions are sufficient.

P3 - Feedbacks between land use, soil density, water availability and plant functional traits in African savannas

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Savannas cover about 20 % of the earth’s surface and are distributed all over the world. They are home to the majority of the earth’s population and thus of ecological as well as economical interest. Because fundamental dynamical processes in vegetation are driven by soil water availability, and land use as well as climate change are affecting the ecological and ecohydrological processes in savannas, the understanding of these feedback mechanisms is elementary. Our study area was located in the semiarid Namibian Kalahari (MAP=250 mm), on a private game farm with different habitats ranging from grasslands to areas with a high bush cover. The data was collected at the end of the wet season 2012, from March to May 2012. We examined soil density, soil water content and plant functional traits along a gradient of different land use intensities. We found out that shrub encroachment as a proxy for grazing intensity correlates both with soil abiotic factors and plant functional traits.

P4 - Partitioning evapotranspiration a Mediterranean oak savannah - validating the Craig and Gordon model and the impact of pasture

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Stable isotopes of water provide a valuable tracer for water movements within ecosystems and are used to estimate the contribution of transpiration to ecosystem evapotranspiration (ft). We tested the Craig and Gordon equation against continuous field measurements of isotopic composition of evaporation and assessed the impact for partitioning evapotranspiration. Therefore, evaporation (E) and its isotopic signature ($^{18}O_E$) on bare soil plots, as well as evapotranspiration (ET) and its isotopic composition ($^{18}O_{ET}$) of an herbaceous understory layer was measured with a cavity ring-down spectrometer connected to a soil chamber throughout 2011 on a field site in central Portugal. We quantified the variation in $^{18}O_E$ arising from uncertainties in the determination of environmental input variables to the Craig and Gordon equation: the isotope signature at the evaporating site ($^{18}O_e$), the temperature at the evaporating site (T_e), and the kinetic fractionation factor (α_k). Eddy covariance technique was used to quantify ET on ecosystem level. We could hence partition between oak and understory transpiration and soil evaporation.

Our results demonstrate that predicting $^{18}O_E$ leads to good agreement with measured $^{18}O_E$ given that the temperature and isotope profiles of the soil are thoroughly characterized. However, modeled $^{18}O_E$ is highly sensitive to changes in T_e and $^{18}O_e$ as well as α_k. The relative contribution of understory ET was up to 50 % both in spring and fall; however, whereas understory transpiration played a dominant role during spring, soil evaporation dominated the understory flux in fall. Due to their access to groundwater oak trees maintained a relative stable transpiration rate throughout the year.

These findings provide a first comparison of laser-based and modeled isotopic compositions of evaporation based on the Craig and Gordon equation under field conditions. This is of special interest for studies using stable isotopes to separate soil evaporation and plant transpiration fluxes.

Session 30 - Free Session

Chairs: Florian Jeltsch, Jasmin Joshi, Dirk Lohmann

O1 - Laboratory experiments on the adaptive strategies of nematodes from mofette fields (natural CO_2 springs)

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In mofette fields, CO_2 is ascending upwards from a natural geogenic source, diffusing and altering the atmosphere in the soil layers. In consequence, a small-scale mosaic of different CO_2 concentrations of up to 100% is found in the uppermost soil layers. Extreme CO_2 concentrations and concomitant hypoxia and soil acidity demand specific adaptations from soil organisms. We investigated survival, fertility, activity and regeneration ability of two nematode species under highly elevated CO_2 concentrations. *Acrobeloides* cf. *buchneri*, collected from mofette fields at spots with up to 60% CO_2 and *A. nanus*, found in spots with less CO_2 (0 – 20%), were compared. Our first laboratory experiments revealed that individuals of both species survived exposure at up to 100% CO_2, although the percentage of inactive nematodes increased from 20 % CO_2 on. Under subsequent ambient conditions, it took minutes to hours for their reactivation. The duration of this lag phase depended on CO_2 concentration and on the species. In contrast to nematode movement, respiration started immediately when oxygen was available again. We compared respiration rates of nematodes after exposure at 100 % CO_2 with those of untreated nematodes. Respiration rates of treated *A.* cf. *buchneri* did not differ from those of untreated individuals. *A. nanus*, on the other hand, showed significantly reduced respiration rates after exposure to 100% CO_2. From the differences in their ability to stay active or recover, we conclude that *A.* cf. *buchneri* is better adapted to high CO_2 concentrations than *A. nanus*. The underlying physiological mechanism behind inactivity and revival might involve quiescence or even cryptobiosis.

O2 - Distribution of small mammals and their infestation by *Ixodes ricinus* ticks in an agricultural setting

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Agricultural intensification and landscape changes during the last decades influence biodiversity. Since most of the landscape in Northern Europe is in agricultural use, research on biodiversity has to include landscape structures. Although small mammals are important players in the ecosystem, in highly cultivated areas, they are frequently regarded only as pests. Besides their value as basic food source for predators, small mammals, and especially rodents, serve as hosts for ticks and fleas. Furthermore, rodents are reservoirs for vector-borne pathogens, such as the agent of Lyme-disease, and thus may impact public health.

Within the interdisciplinary framework of AgroScapeLabs (www.scapelabs.org), the aim of the present study is to examine whether land use patterns influence the community composition of small mammals and their infestation with ticks on a landscape scale.

Therefore, we live-captured small mammals, such as voles and mice, in a highly diverse agricultural landscape in north-eastern Germany. The rodents were inspected for ectoparasites and feeding wood ticks, *Ixodes ricinus*, were removed. By GIS-based analyses, the abundance and composition of the rodent fauna as well as the intensity of tick infestation was correlated with particular landscape elements and with landscape complexity ranging from semi-natural to highly productive agricultural land. Additionally, small scale gradients of various biotic and abiotic parameters were examined to identify parameters relevant to predict rodent and tick abundance. Understanding the occurrence of ectoparasites and their hosts at a landscape scale may help to devise management strategies to reduce risk for people.

O3 - The influence of biological soil crusts on soil erosion on shaded slopes: Experimental Research with Rainfall Simulation

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The importance of biological soil crusts (BSC) for soil hydrological behavior in arid and semiarid landscapes is widely acknowledged. However, little research has been done on the influence of BSC on the hydrological behavior of soils in the European temperate zone. From a taxonomical and phyto-sociological point of view the crusts in this region are well documented, but their effects on soil properties, such as erodibility or infiltration rate are as yet understudied. For this reason, our objective is to investigate whether BSCs lead to a decrease in sediment yield of shaded slopes. The study sites are located next to forest roads in two different woods in Rhineland-Palatinate, Germany. We designed a small portable rainfall simulator to do measurements on steep slopes. By aid of capillary tubes large raindrops could be produced (3.5 – 4 mm) to imitate the drip line under forest. We conducted rainfall simulations on small-scale plots, because uninterrupted BSCs occur only in small patches. To receive comparable data we studied plots with encrusted soil surface and control plots without any vegetation. Each plot was exposed to an intense rain simulation of 52 mm in 15 min. The biological soil crusts had a quantifiable effect on splash and interrill erosion. The sediment yield decreased significantly: it was about seventy times lower on the BSC- plots than on the non-vegetated control plots. Statistical analysis of the collected data has shown significant differences between the sediment yields of the two types of lichens and the control plots. Compared with the *Baeomyces*-covered plots, a slightly higher sediment yield could be measured on the *Cladonia*-covered plots, whereas the highest soil loss was detectable on the control plots. Conclusively, the results of soil erosion measurements present empirical evidence for the influence of biological soil crusts on soil erodibility, not only in arid and semiarid regions, but on forest slopes of the temperate zone as well.

O4 - Oxidative stress of long-lived mammals varies with dietary niche

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Oxidative stress – an imbalance between reactive oxygen species (ROS) and antioxidants – is regarded as the main cause of ageing in animals. ROS are produced by every aerobial organism and damage proteins, lipids and DNA. The negative effect of ROS can be mitigated by neutralising antioxidants, which are partly synthesised by the organisms, but also partly ingested with food. Feeding on diets with high antioxidant content such as fruits should therefore reduce oxidative stress in animals.

Bats are despite their high mass-specific metabolic rate unusually long-lived and cover a variety of ecological niches. Here, we ask whether oxidative stress differs between dietary niche, measuring both ROS and antioxidants in the blood of 13 bat species. Furthermore, we compared parameters of oxidative stress of bats with those of similar sized, shorter living and terrestrial mammals from the literature. We found that bats have a significantly lower level of oxidative stress than mice and rats. Bat species feeding on fruits have the lowest oxidative stress level, followed by omnivorous bats and species feeding on insect and blood. Although the level of antioxidants measured in plasma did not differ between dietary niche, the level of ROS was lower in frugivores than in other species. Potentially, frugivores ingest more antioxidants with food and thus are able to neutralise more ROS, leading to lower oxidative stress levels than in species feeding on less or no fruits.

We conclude that the low levels of oxidative stress in bats may account for their long live span. Furthermore, we showed for the first time that oxidative stress in mammals varies according to dietary niche, shedding new light on the influence of the ecological niche on proximate mechanisms of ageing.

O5 - Nitrogenous compounds distinguish the herbivore induced volatile blend in poplar

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When plants are attacked by insect herbivores, they release specific volatiles that can comprise signalling molecules in indirect plant defense, attracting herbivore enemies. After local herbivore damage, volatiles are often also systemically emitted from nearby undamaged organs. In the literature this systemic emission has been reported as qualitatively similar but lower in intensity to local volatile release, but systemic vs. local emission patterns and their role in indirect defense have not been well described for most plant species. In this study the local and systemic volatile emission from *Populus nigra* (black poplar) after damage by *Lymantria dispar* (gypsy moth) and *Phratora vulgatissima* (blue willow beetle) under field and laboratory conditions was investigated and the effect of the odour blends on the behaviour of the braconid parasitic wasp *Glyptapanteles liparidis* was studied. While terpenes are abundant in both local and systemic blends, minor nitrogen containing compounds (indole, oximes and nitriles) and green leaf volatiles are only found as locally released volatiles. In an olfactometer experiment parasitic wasps clearly orient towards the herbivore-induced local poplar odour. Under field conditions, the emission of nitrogenous volatiles increases with increasing levels of herbivore damage. Although the abundance of nitrogenous volatiles released from black poplar upon herbivory is low, these compounds likely comprise high informational value in indirect tree defense.

O6 - Biodiversity as a content of education at universities - The visual method of classification

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The estimation that there is a heavy decrease in pupil´s knowledge of species leads to the question, how this knowledge is represented in students of the subject biology. To answer this question, investigations were made at three German universities. To get a quick and valid collection of data, the Visual method of Classification (VC) was developed in 2012. This method is a combination of questionnaires and pictures of characteristic attributes of plants and animals. The census was conducted with a pre-test/post-test procedure.

The scientific questions of this investigation are: How detailed is the knowledge of the students at the beginning and the end of the courses? To which contents are there good accessions in knowledge? Does the method of instruction lead to a significant impact on the learning success?

The results allow first evaluation of the growth of competence in determining plants and animals at the start and after the learning process had been realized. The learning success in botanic topics seems to be better than in zoological topics. Furthermore correlations between the knowledge of taxa, the characteristic attributes and the ability to assign the correct picture are suggested.

In 2013 the investigation will be conducted at ten universities in Germany. The scientific ambition is to test the parameters that influence the process of learning and to modify the methods of teaching. Finally the effectivity and sustainability of the instruction including topics of species knowledge shall be improved.

O7 - Assessing urban green infrastructure and provisioning ecosystem services in Dar es Salaam, Tanzania

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Climate change threatens the cities and fast urbanizing coasts of African cities where about 38 percent of Africa’s population lives. By 2030, this is expected to grow to approximately 54 per cent of Africa's projected population of around 1405 million (UNCHS 2001).

CLUVA – Climate Change and Urban Vulnerability in Africa - is a EU funded research project with 14 partners from Africa and Europe. In our research group we explore the potential role of green infrastructure for climate change adaptation by providing vital ecosystem services such as heat island moderation, flood retention and storage of biomass in urban trees and shrubs.

The city of Dar es Salaam was classified into urban morphology types (UMT) combined with land cover survey from aerial imagery (e.g. Pauleit and Breuste 2011, Gill et al., 2008). These analyses were conducted for two time steps to investigate the dynamics of urban green and associated ecosystem services.Storage of woody biomass is explored in this paper as an example for a supporting ecosystem service. From the combination of woody landcover types with basal area measurements in selected UMTs biomass regressions were derived to extrapolate standing timber volume in all UMT classes according to the specific woody landcover.

The cover of evapotranspiring surfaces ranges from 42% for informal settlements to 59% for condominiums. Overall, the city stores an estimated 8.63 Mio t of woody biomass or 57,4 t/ ha. It varies strongly between urban morphology types. This will affect the provision of ecosystem services and vulnerability to climate change of the settlement types.

The paper presents one of the very first comprehensive assessments of green infrastructure for an African city. The approach of urban morphology types and land cover mapping proved key for assessment of ecosystem services provision. Results support the important role of the green infrastructure for adaptation of this city to climate change.

P1 - Portal Beee - the Citizen Science Portal for the Berlin-Brandenburg Area

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In the last few years, it has increasingly been recognized that the biodiversity research lends itself well to the involvement of volunteers in designing research projects and in data collection. Volunteers can provide their views on questions of societal relevance and can contribute data on the observation of many animals and plants. While this concept is not suitable for all research questions, it can be highly valuable in many cases: more extensive datasets can be collated with the help of volunteers than by scientists alone, and the involvement of citizens can also lead to higher public acceptance of scientific results. Conversely, interested citizens gain knowledge about biodiversity, can contribute to solving interesting scientific problems, and connect their outdoor hobby with science.

Within the Berlin-Brandenburg Institute of Advanced Biodiversity Research (www.bbib.org), an online platform "*Portal Beee" - Biodiversität erkennen, erforschen, erhalten*" will be established to foster Citizen Science as an approach in research. In general, Portal Beee will be a knowledge exchange platform for the public and the science community in the Berlin-Brandenburg area. The public awareness of biodiversity research will be raised through active participation of the general public in suitable scientific projects. Scientists will have the possibility to announce projects on this platform and collect data through an online form for data submission. Citizens from Berlin and Brandenburg will find detailed information about the projects, material for the surveys and news about the project progress and results. In this way, citizens have the opportunity to contribute to scientific progress and increase their knowledge about biodiversity issues. The Citizen Science Platform will be closely connected to BBIBs ScapeLabs, an experimental platform focusing on the landscape scale and to the Citizen Science activities of the Museum für Naturkunde.

P2 - Effects of national park exhibitions on visitor's nature awareness

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Despite the long history of visitor studies little is known about the effects of nature exhibitions on the emotional perception of the visitors. This study took place in three of the World Natural

Heritage sites "Ancient beech forests in Germany" (Kellerwald-Edersee, Jasmund and Hainich). More than 300 visitors were interrogated in a quantitative pre-post-interview.

The bigger part of the respondents felt already emotionally connected with nature and was interested in nature protection when they entered the exhibitions. One out of three respondents named "forest" as spontaneous association of nature. Statistical tests revealed a change in the perception of wilderness and in items concerning the emotional relationship to nature. Furthermore highly significant effects on the visitors' emotions after their visit were found; the respondents felt more relaxed, more thoughtful, more stimulated and less irritated. Based on statements of the visitors three main aspects caused a change in their relationship to nature: raising the awareness for the unknown and unseen in nature, thought-provoking incentives and providing new and interesting information.

National park exhibitions do have a positive effect on visitor's nature awareness. Thus, national parks do fulfill their objective of environmental education and maybe we can learn from this kind of exhibition how to communicate also new scientific findings by affecting the recipients emotionally.

P3 - Immune response increases oxidative stress in long-lived bats

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Oxidative stress - the imbalance between reactive oxygen species (ROS) and neutralising antioxidants - is regarded as the main cause of ageing in aerobial organisms. The level of ROS should increase during infections as part of the activation of an immune response, leading to oxidative damage on proteins, lipids and DNA. Yet, it is unknown how long-lived organisms, especially mammals, cope with oxidative stress. Bats are known to carry a variety of zoonotic pathogens and at the same time are despite their high mass-specific basal metabolic rate unusually long-lived, which may be partly caused by low oxidative damage of organs. Here, we ask if an immune challenge causes oxidative stress in free-ranging bats. We injected 20 short-tailed fruit bats (*Carollia perspicillata*) with bacterial derived lipopolysaccharides (LPS) and 20 individuals with phosphatebuffered saline solution (PBS) as a control. Individuals injected with LPS showed an immune reaction by increased white blood cell count after 24h, whereas there was no significant change in leukocyte counts in control animals. The biological antioxidant potential (BAP) remained the same in both groups, but ROS increased after treatment with LPS, leading to a significant increase in oxidative stress in animals mounting an immune reaction toward the inflammatory challenge. Control individuals did not show a change in oxidative stress. We conclude that in a long-lived mammal, even high concentrations of antioxidants can not immediately neutralise all ROS produced during a cellular immune response. Thus, fighting an infection may lead to oxidative stress in bats.

P4 - Vegetation of birch forests in Western Siberia

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Historically, the Central European landscape was characterized by vast forests and open ecosystems were scarce. During the early Holocene massive changes in the landscape structure resulted in the emerging of a variety of open ecosystems. For a better understanding of the development of these processes a practical method is to study modern analogues, which can be found in the ecosystems of West Siberian forests. To identify specific relations we studied open birch forest and grassland vegetation in the eastern of the Ural in the southern part of the Oblast Tyumen. Along a south-north transect, three test areas were chosen, representing a climatic and eco-zonal gradient. We sampled vegetation and measured structural parameters in plots of 100 m^2. We divided the forest samples into four forest types with different characteristics regarding mainly to humidity and the grade of canopy cover. The species richness was also most affected by the canopy-transmitted light and humidity. Comparing the samples with Central European classification, our species inventory showed beside typical forest species a fairly high amount of open landscape species, especially of wet grassland species. In the grassland, vegetation of open landscape, especially of dry grasslands mainly dominates.

This shows a shift of open landscape species into the forest and can be explained by the relative site constancy of plants. Forests are open and in hot continental summer climate wet grassland species find appropriate growing sites in the temperature-controlled forests.

These results give further evidence, that late-glacial open-canopy forests in Central Europe were rich in light-demanding species and were the origin of the flora of the later open ecosystem.

P5 - Biomass equations for caatinga trees compiled from case studies in regenerating areas and natural vegetation in North-East Brazil.

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Seasonally dry tropical forests (SDTFs) are the tropical habitats that suffer most from high pressure of human settlements and exploitation, and the Caatinga (Brazil) is one of the most extensive contiguous SDTF areas in South America. The forest is a resource for many stakeholders in the region: it provides construction timber, fodder for maintenance of livestock, and extraction of non-timber products and of fuelwood plays an important role. However, trees are not only an economic asset, but the key element of nutrient- and water cycles in the Caatinga wildlands. By tree removal or through grazing the natural habitats are altered in a destructive manner and become prone to degradation and desertification. The severe drought in 2012 emphasizes the importance of research on sustainable land-use in seasonally dry tropical forests that withstand climate change.

Caatinga vegetation, due to the irregular and limited rainfall of the semiarid region, rarely reaches heights above 20m and is dominated by small and often multiple stemmed trees and shrubs. The last decade has seen a growing amount of research in the SDTFs of Latin America and different approaches of estimating biomass in semiarid regions can be found in the literature. Height may or not be included in the equations, diameter may be measured at ground level or at breast height.

The poster summarizes the results of biomass estimations from several Caatinga case studies for eight important species of the region: *Anadenanthera macrocarpa, Aspidosperma pyrifolium, Caesalpinia pyramidalis, Croton sonderianus, Jatropha mollissima, Mimosa hostilis, Myracrodruon urundeuva* and *Schinopsis glabra*. Also, it compares the different inventory approaches to prepare the ground for the field work of a doctoral research study on conservation status and regeneration potential of seasonally dry tropical forests in Brazil. The work enhances the reception of Brazilian literature, that to a large extend is published in Portuguese.

P6 - Ecological resilience of population cycles: a dynamic perspective of regime shift

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Studies of regime shifts have so far considered a simple equilibrial case that consists of two equilibria and an unstable point dividing the basin of attraction. Because a natural ecological community can exhibit non-equilibrium population dynamics, such a simple model of regime shift is a special case of more general one, in which attractors and basin boundaries can have highdimensional structures. We introduce a numerical method to approximate basin boundaries and quantified the temporal variation of ecological resilience of three-species models as examples. The results showed that the ecological resilience in a multistable system with non-point attractors is quite different from that of point attractors because of the effect of the geometric configuration of the attractors and basin boundary. Our result provides a new dynamic aspect of ecological resilience that has not been considered in a simple abstracted model showing only equilibrium dynamics.

Session 31 - Artificial light at night in terrestrial and aquatic systems

Chairs: Franz Hölker, Christian C. Voigt, Michael M. Monaghan, Stephanie I. J. Holzhauer

O1 - Spatial analysis of light pollution sources in an urban context

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The presence of light at night is one of the most obvious hallmarks of human habitance in an ecosystem. Humans light their nighttime environment for many different reasons, including the desire to make navigation easier, advertising products, and to reduce perceptions of fear associated with darkness. For purposes of categorizing these sources of artificial night brightness, aerial surveys bridge the gap between the problematically low resolution of current satellite imagery and the tremendous effort required to perform a ground based survey at large spatial scales. The first ever high resolution spatial analysis of light sources in an urban area is presented. A high resolution (1 m) mosaic image of the city of Berlin, Germany at night is spatially analyzed to identify the major sources of light pollution in the city based on urban land use data. An area-independent "brightness factor" is introduced that allows direct comparison of the light emission from differently sized land use classes, and the percentage area with values above average brightness is calculated for each class. Using this methodology, lighting associated with streets has been found to be the dominant source of zenith directed light pollution (31.6%), although other land use classes have much higher average brightness. These results are compared with other urban light pollution quantification studies. Future applications of high resolution datasets such as this one could include: studies of the efficacy of light pollution mitigation measures, improved light pollution simulations, the relationship between artificial light and ecological parameters (e.g. circadian rhythm, fitness, mate selection, species distributions, migration barriers and seasonal behavior), or the management of nightscapes.

O2 - Ecological research applications of aerial night photography

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Artificial lighting can have a range of effects on ecological processes, functions and communities. Lighting is also highly varied, with cities in particular having a broad variety of lamp densities and spectra. Such diversity of treatment and response requires a range of research tools to be employed

at different spatial scales. Here we present one tool – aerial night photography; and illustrate two ecological research applications.

We captured high resolution colour night photographs for an entire city in England and processed them to create GIS layers representing lamp locations and incident lux. First, we used these metrics as explanatory variables in avian distribution and abundance models. Birds were surveyed at 70 sites over three sampling periods, along an urbanisation gradient. Patch and landscape land-use metrics were derived from ground surveys, GIS mapping and aerial photography. Lighting was found to be significant for some species, in addition to metrics such as built density.

In a second study, we used aerial night photography to translate the results of field studies of bat movement into a measure of functional connectivity for the entire city. Surveys at gaps in tree lines revealed that increasing both the gap width and illumination negatively impacted crossing probability for one species of bat. These models were then applied to high resolution GIS maps of urban trees and lighting at the city extent. The results suggest that it should be possible to improve functional connectivity for certain urban bats by intervening at the scale of individual trees or lamps.

Aerial night photography is useful for mapping key lighting metrics at the city scale and is particularly suitable when fine grained data is required. Whilst not the only way to measure artificial lighting, we expect this to have a broad range of applications for ecological research, as well as for infrastructure management and change detection.

O3 - Stop the green Biofilm - does LED-Light reduce growth of Lampenflora algae in touristic used dripstone caves?

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Caves are ecosystems in complete darkness. To manage a show cave artificial illumination is necessary which may cause growth of phototrophic organisms called *Lampenflora*. The first organisms are cyanobacteria, followed by green algae and later mosses as well as ferns are observed. This colonizing process runs with photon flux densities lower than the common photosynthetic compensation point of approximately 20 µmol photons. These organisms may damage the surface of speleothems.

The aim of the present study was to investigate the possibility of managing a show cave sustainable under LED illumination. The theoretical background why using LED light to illuminate show caves is the fact, that there is no light emission at the absorbance maximum of the photosynthetic pigments.

In the present study we measured the growth of two typical cave species of cyanobacteria (*Synechocystis spec*) and green algae (*Chlorella vulgaris*) under various intensities of white LED light.

The culture experiments were carried out at 10 and 30 µmol photons/m^2s over a period of 8 h/d. In the control treatment algae were grown under optimal photosynthetic light conditions. Growth was monitored by means of absorbance. In further experiments the growth response of the species was analyzed at 10 µmol photons/m^2s at the light regime (100 min and 200 min/7d) in the show cave '*Herbstlabyrinth*' (Breitscheid, Germany).

Under LED-Light the culture experiments showed a significant reduction of algae growth up to decrease of the population of the green algae. This effect was not observed by cyanobacteria.

These unexpected results lead us to questions about the adaptation process in the population of cave algae.

The growth of photosynthetic organisms in the cave is completely hampered at low light quantity levels and light duration periods that are in accordance with artificial light conditions in show caves.

O4 - Sex-specific mortality rates induced by light pollution - a modeling approach

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Many insects actively congregate around light sources during the night until they die of exhaustion and many predators such as spiders and bats take advantage of this situation. Beside these effects it is reported for many nocturnal insect species that light trap catches are dominated by males or females. For butterflies it appears common that males are reproductively active before females (protandry), but cases where females are reproductively active before males (protogyny) are also known. Thus, for estimating the consequences of artificial light for insect populations it is essential to understand the impact of sex specific mortality rates. For butterflies there exist a few discrete generation models which describe the connection of equal mortality rates of males and females and the fraction of unpaired females. To address our question we choose a well-established model by Zonneveld and Metz (1991). Based on this we developed a model where the fraction of fertilized females is used to quantify the impact of sex-specific mortality rates. We found, that increasing mortality rates of the earlier appearing sex leads to an extreme reduction of fertilized females. This impact can be reduced by a plastic hatch strategy.

We conclude that even if insects are not able to adapt to artificial lighting by a reduced vulnerability to attraction to light they might respond to the impact of lighting with an adapted hatch strategy.

O5 - Artificial light at night deters frugivorous bats from dispersing seeds

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The entire world population growth of the forthcoming decades will concentrate in urban areas, particularly in less developed countries. Urban areas will sprawl and introduce artificial light into formerly dark rural habitats. Consequently, light pollution is spreading fast all across the world, which might be deleterious for light sensitive wildlife. Obligate nocturnal animals such as bats can be expected to be particularly affected, since artificial light is present in urban as well as in many rural habitats during their nocturnal activity period.

Among bats, a large diversity of feeding habits evolved. In the tropics many bat species are specialized on nectar and fruits. Those frugivorous bats are particularly important for forest regeneration in the Neotropics, since they are among the most effective seed dispersers during early succession. Short-tailed fruit bats (genus *Carollia*), for example, constitute the main disperser of many *Piper* species - pioneer plants in the Neotropics that grow at forest edges or gaps and thus are key to reforestation. However, due to this habitat preference, *Piper* plants are predisposed to become affected by artificial light, for example if street lights become installed along roads. If bats avoid illuminated areas, human encroachment into natural habitats may compromise bat-mediated seed dispersal due to an increase in light pollution. However, the effect of artificial light on frugivorous bats has not yet been studied experimentally.

We asked whether light is reducing the visitation rate, and thus the dispersal of seeds by *Carollia* bats. In a dual choice experiment with captive bats, *C. sowelli* explored a dimly illuminated compartment less often than a dark compartment, and were less likely to harvest fruits in the illuminated than in the dark compartment. Also in free-ranging bats, we observed that *Piper* infructescences were less likely to be harvested when plants were illuminated by a street lamp than under natural darkness.

We conclude that succession and forest regeneration may suffer heavily from urban sprawl when nocturnal seed-dispersers, such as bats, reduce their activity in areas illuminated by street lamps. This might be particularly relevant in the tropics, where ecosystem services of bats are ecologically important for ecosystem functioning, and where at the same time the potential for light pollution to increase is very high.

P1 - Effects of garden LED lights on small rodent behaviour and physiology

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We investigated the effects of solar-powered LED garden lamps on small mammals Voles (*Myodes glareolus* and *Microtus arvalis*) are common prey for owls and are known to reduce their activity during moonlit nights. Even the dim light of LED garden lamps may enhance visibility for owls and possibly the predation risk for voles. We investigated illumination effects at different seasons. Solar powered lights run for short time during winter and the entire night during summer, thus enhance seasonality of light.

Voles' movement and activities were tracked using automated radiotracking. Stress response was monitored measuring non-invasive fecal glucoticoid titers. Voles' onset of breeding was compared between illuminated populations and populations with natural light.

During summers shifted their activity into the day and reduced their home ranges. Results from winter and spring will be discussed.

Session 32 - Spatial ecology: from individual movement to geographic distributions

Chairs: Emanuel Fronhofer, Alexander Kubisch

O1 - Where am I and why? Synthesizing range biology and the eco- evolutionary dynamics of dispersal

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Although generations of researchers have studied the factors that limit the distributions of species, we still do not seem to understand this phenomenon comprehensively. Traditionally, species' ranges have been seen as the consequence of abiotic conditions and local adaptation to the environment. However, during the last years it has become more and more evident that biotic factors - such as intra- and interspecific interactions or the dispersal capacity of species - and even rapidly occurring evolutionary processes can strongly influence the range of a species and its potential to spread to new habitats. Relevant eco-evolutionary forces can be found at all hierarchical levels: from landscapes to communities via populations, individuals and genes.

We here use the metapopulation concept to develop a framework that allows us to synthesize this broad spectrum of different factors. Since species' ranges are the result of a dynamic equilibrium of colonization and extinction events, the importance of dispersal is immediately clear. We highlight the complex interrelations and feedbacks between ecological and evolutionary forces that shape dispersal and result in non-trivial and partially counter-intuitive range dynamics. Our concept synthesizes current knowledge on range biology and the eco-evolutionary dynamics of dispersal.

O2 - Optimal density dependent dispersal distances

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Dispersal is a key process in basically all living organisms. However, theory on dispersal has often simplified the process into a spatially implicit phenomenon described by a dispersal rate in a population with no (kin) structure. We created an individual based model with a novel approach that allowed us to gain insights in how the optimal dispersal distance distribution changes with local density. Furthermore, we were able to switch the effect of kin competition on or off. Intuitively, we found that mean dispersal distances increase with local density, however, we also found that the shape of the distance probability function changes with density and that kin competition leads to more and further dispersal at both low and high densities.

O3 - The pseudoscorpions (arachnida) of Serbia

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The territory of Serbia is home to 74 pseudoscorpion species belonging to 10 genera (*Chthonius*, *Tyrannochthonius*, *Acanthocreagris*, *Neobisium*, *Roncus*, *Chernes*, *Allochernes*, *Chelifer*, *Dactylochelifer*, *Rhacochelifer*) and four families (Chthoniidae, Neobisiidae, Chernetidae, Cheliferidae). The most abundant genera are *Roncus* (with 28 species or 37.84%), *Chthonius* (with 20 species or 27.03%) and *Neobisium* (with 19 species or 25.68%). Of 74 species, 50 ones (67.57%) are endemics of Serbia, that mostly belong to the family Neobisiidae (with 34 species or 68%). Of the total number of species, 47 ones are strictly protected by the Rulebook on the Declaration and Protection of Protected and Strictly Protected Wild Species of Plants, Animals, and Fungi of the Republic of Serbia (32 species of Neobisiidae and 15 species of Chthoniidae). According to their present distribution, the established 74 species can be relegated to the four zoogeographical complexes: cosmopolitans, widely distributed species, European species, and endemics. The endemism and their relictual nature can be regarded as a result of a relative isolation of the mountains of the Balkan Peninsula as compared with the lowlands in the context of paleo-environmental changes during the Tertiary. The distribution of pseudoscopions is presented in UTM maps.

O4 - Depth distribution of the soil oribatid mite assemblage of a dry grassland

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In the framework of the debate on niche vs. neutral processes of community assembly, we analysed the oribatid mites of a dry grassland in the nature reserve of Mallnow (Brandenburg, Germany). The study was performed at a fine scale (15 x 15 m plot) along a steep gradient in major soil parameters (pH, water% (s.d.w.), C and N) using a spatially explicit sampling design. By cutting the top 10 cm of the soil cores into 2 cm slices, we aim at adding the vertical dimension to the analysis of community assembly. By performing a pairwise co-occurrence analysis with the 27 Oribatid species found, we have identified species pairs that show the effects that either (1) depth or (2) horizontal variation in the soil environment or (3) both have on community structure. Depth may imply either vertical zonation or simply more space for niche partitioning, regardless of zonation. Depth thus appears to be a fundamental, yet not well investigated dimension of soil animal community assembly.

O5 - Holocene changes in vegetation, treeline location and climate at the Khatanga region, northern Siberia, derived from a lacustrine pollen record

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Treeline changes are widely known for many locations in the northern Siberian Arctic. Thus, the arctic biomes are a dynamic system in time and space. Especially palaeoecological methods reveal these temporal and spatial compositions of vegetation. Besides empirical data and statistic calculations, simulations can also give insight on the vegetation dynamics at different points in time. Since ecosystems contain temporal and spatial distribution, biotic and abiotic factors are influencing these systems with different parameters (e.g. mean July temperature, precipitation etc.). Those parameters are necessary to estimate the appearance of landscape through simulations. However, at some arctic locations the biotic and abiotic factors and their effect on treeline changes and vegetation are still unknown. Here we show first results about the development of vegetation around a Siberian lake at the Khatanga region with palynological and statistical methods. Different sediment cores from lakes or moss monoliths close to, by or above the treeline were collected in the Khatanga region and will be examined in an upcoming project. One core was already analysed and reveals changes in vegetation over the last thousand years. Also determinations of different *Pediastrum* species were carried out simultaneously with the palynological analysis. Changes in species abundance of Pediastrum are assumed to be a proxy for arctic climate conditions. Additionally the weighted averaging partial least squares regression (WA-PLS) was used for climate reconstruction based on the palynological data. Climate conditions based on this transfer function can be connected to the reconstructions of the vegetation of the past and will help refine simulations. This first study was an initial analysis and will be supplemented by further qualitative and quantitative analysis of the Khatanga region to enlighten the Holocene treeline changes.

O6 - Landscape scaled distribution of the tick Ixodes ricinus depending on microclimate and soil condition

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The knowledge about spatial ecology is often used to protect the species' habitat, especially when species are endangered. However, such knowledge can also be used to mitigate the transmission of vector-borne diseases. The tick *Ixodes ricinus* is the most significant carrier for harmful disease to humans and animals in Central Europe such as Lyme disease and encephalitis. Knowledge of the spatial distribution of this tick and its environmental habitat is therefore an important key to protect human health.

Because of ticks' hidden life, research on their distribution, population dynamics and transmission pathways of pathogens is challenging and the underlying mechanisms still not well understood. Therefore, we collect population data from *Ixodes ricinus* from a range of 25 different forest sites throughout South-western Germany, with a particular focus on mixed and deciduous forests. Several environmental variables, such as microclimate, tree species composition and soil-water content are measured. Based on this field data and further meteorological and physical data a species distribution model is calculated. This is one step in the development of a hazard map for pathogens transmitted by *Ixodes ricinus.*

P1 - A mechanistic model of intelligent animal movement and home range formation

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A large number of animals restrain their movement activities to familiar areas which leads to the establishment of home ranges. The factors that shape the dynamics of such home ranges remain largely unclear although understanding the determinants of home range establishment and shifts is highly relevant for conservation biology. So far, theoretical models of home range emergence are based on random walks and assume a fixed home range centre. However, even if a random walk might describe real movement patterns acceptably well, there is no reason to assume that animals move randomly. We therefore propose a simple mechanistic model of animal foraging which is based on information use and memory in order to increase our understanding of the processes that lead to movement decisions and ultimately home range establishment.

We model an animal with a limited perceptual range and basic information storage capacities. This 'spatially informed forager' constructs an internal map of its environment by using perception, memory and learned or evolutionarily acquired assumptions about landscape attributes. It uses Bayesian updating to include perceived and inherited information into its memory.

We analyse the formation of home ranges as a function of landscape attributes such as resource clustering and regrowth speed. We show that, in spite of their limited perceptual range, spatially informed individuals are highly efficient as search is optimized at multiple scales: inter-patch movement is effected in a straight line walk and intra-patch foraging resembles a grid-line search. The resulting movement patterns may include foray search behaviour and resource dynamics can lead to the establishment of home ranges without the need to assume a fixed home range centre. In summary, we show that intelligent movement which includes memory and basic information processing capacities leads to the emergence of home ranges.

Session 33 - Common mechanisms of invasions in aquatic and terrestrial systems?

Chairs: Ewald Weber, Guntram Weithoff, Jasmin Joshi

O1 - Seeking common patterns in aquatic and terrestrial invasions - towards a framework for understanding future trends

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Terrestrial and aquatic ecosystems fundamentally differ in their diversity, complexity, and dynamics. Specifically, they differ in constraining environmental pressures, in mean species diversity, in mean individual life-span, in the relationship between body size and trophic position, in the chemical classes of compounds structuring food webs, and in the dynamics of carbon and nutrient fluxes. Therefore, biological invasions in aquatic ecosystems may be driven by other factors than invasions in terrestrial ecosystems. However, little attention has been paid to the question about common patterns and differences governing invasions in these different types of ecosystems. We address some issues and outline what kind of studies would be needed to explore shared mechanisms.

O2 - The probability of invasion caused by global trade in marine and terrestrial systems

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The global spread of species is considered to be one of the major threats to biodiversity. During the last decades the rate of spreading has strongly increased mainly due to globalisation with its ever increasing demand for cargo transport. However, the global spreading dynamics of alien species remain poorly understood. We developed a simple and flexible model framework to quantify the probability of invasion caused by global trade and adjusted the framework to (1) marine bioinvasion caused by global shipping and (2) the spread of terrestrial vascular plants through global trade. In the marine study, we combined data of nearly 3 Mio ship movements, ballast water releases, environmental heterogeneity and biogeography. The model predictions agree with observations in the field at different locations and scales. In the terrestrial study, we took advantage of a global coverage of trading patterns. The model explains a large amount of the observed variability of established plants reported for nearly 100 countries. The models allow to determine the global highways and hot spots of invasion and the source regions from where an invasive species is likely to occur. The studies show that the model framework can easily be adapted to different introduction pathways and taxa specific predictors.

O3 - Human land use as a trigger for the spread of invasive species

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Existing frameworks on biological invasions focus on the ability of introduced species to cope with abiotic and biotic conditions of the new environment, and on their ability to reproduce and disperse. Human influence on these processes is recognized especially during the establishment stage. During establishment, human action increases propagule pressure or creates disturbance regimes which present a window of opportunity for introduced species to establish. In this project, we investigated how human actions influence the abundance of already established invasive species. We hypothesised that the number of terrestrial alien plant species was related to human land use intensity. We expected that within highly managed anthropogenic landscapes, the abundance of invasive species was suppressed by active landscape maintenance. At the other end of the spectrum, we expected that pristine natural habitats do not offer windows of opportunities for alien species to establish. By contrast, we expected greater abundance of invasive species in between these two extremes – namely in extensively used landscapes characterised by increased fallowing, low weed-control, high heterogeneity and disturbed edges. We therefore predicted that the relationship between invasive species distributions and land use intensity should be unimodal, with increased invasive species prevalence at intermediate levels of land use intensity. We tested this hypothesis at the global, and via a regional scale case study. At the global scale, we modelled the occurrence of native and invasive populations of *Rosa rubiginosa* L. using the MAXENT algorithm. At the regional scale, we examined the relationship between land use intensity and invasive plant species in Central Romania, using local indices of land use intensity.

O4 - Interaction of species traits and environmental disturbance predicts invasion success of aquatic microorganisms

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Factors such as increased mobility of humans, global trade and climate change are affecting the range of many species, and cause large-scale translocations of species beyond their native range. Many introduced species have a strong negative influence on the new local environment and lead to high economic costs. There is a strong interest to understand why some species are successful in invading new environments and others not. Most of our understanding and generalizations thereof, however, are based on studies of plants and animals, and little is known on invasion processes of microorganisms. We conducted a microcosm experiment to understand factors promoting the success of biological invasions of aquatic microorganisms. In a controlled lab experiment, protist and rotifer species originally isolated in North America invaded into a natural, field-collected community

of microorganisms of European origin. To identify the importance of environmental disturbances on invasion success, we either repeatedly disturbed the local patches, or kept them as undisturbed controls. We measured both short-term establishment and long-term invasion success, and correlated it with species-specific life history traits. We found that environmental disturbances significantly affected invasion success. Depending on the invading species' identity, disturbances were either promoting or decreasing invasion success. The interaction between habitat disturbance and species identity was especially pronounced for long-term invasion success. Growth rate was the most important trait promoting invasion success, especially when the species invaded into a disturbed local community. We conclude that neither species traits nor environmental factors alone conclusively predict invasion success, but an integration of both of them is necessary.

O5 - Theodoxus fluviatilis re-established in the River Rhine - a native relic or a cryptic invader?

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The freshwater snail *Theodoxus fluviatilis* is the only species of the familiy Neritidae in the River Rhine, but seemed to be extinct for unknown reasons by the turn of the millennium. In 2006, a new population was reported for the River Rhine near the city of Mainz. However, these individuals were morphological distinct from the former populations. Up to now, it is not known whether the current re-establishment of this freshwater snail is based on relict-populations of the River Rhine catchment or on an invasion process of non-resident *T. fluviatilis*. Our aim was to clarify the origin by sequencing part of the mitochondrial COI gene from individuals of four recent and one ancient population of the River Rhine. First results show a strong difference to the ancient analyzed individual, which represents the typical western and northern European haplotype, indicating a different origin of the recently established populations. Despite their different morphology, all analyzed individual belonged to the species *T. fluviatilis*. Only one haplotype was found in the recent population, indicating a low genetic diversity. Comparison with sequences from GenBank showed a 100 % match to individuals originated from the River Danube and the Ukraine. These results show that an invasion of *T. fluviatilis* from the Danube is most likely explaining the re-establishment of the Nertidae in the River Rhine.

O6 - Are polyploid alien plant species the better range expanders? Empirical evidence from temperature and disturbance gradients

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Polyploidization may result in changes e.g. in morphological or physiological plant traits within short time periods. Thus, it may be one mechanism favoring a species to become invasive outside its native range. Polyploids are supposed to have a broader ecological tolerance, e.g. an increased cold tolerance, and thus colonize a wider range of environmental conditions. Patterns along latitudinal gradients show a positive correlation of polyploidy with latitude. This goes in line with the assumption that stressful conditions in marginal habitats favor spontaneous polyploidization. However, such a correlation has not been shown for elevation patterns. Plant invasions in mountains are mainly shaped by a lowland introduction filter; i.e. alien species are introduced at low elevations and spread from there to higher elevations. First, they mostly spread along roads which are the main introduction pathway, but later some species spread from these ruderal sites into more natural habitats. With survey data recorded along an elevation gradient on the island of Tenerife we test the hypotheses that (1) polyploid alien plant species reach higher elevations and occupy a wider elevation range than diploid species, and that (2) polyploids spread more frequently and further away from roadsides. Along the elevation gradient we found 58 alien plant species that fitted in our target group of annual herbs. Thirteen of them were polyploid, 45 were diploid. Polyploids had a significantly wider elevation range than diploid species. Although not significant, they seem to expand their elevation range over time, while the diploids' ranges remained constant. Polyploids also tended to invade natural habitats more frequently than diploids, i.e. from the species occurring at the roadsides a higher proportion of polyploids spread away from the road. Our results suggest that a higher ploidy level supports alien plant invasions in mountains and also enables species to invade native communities. This might be related to a broader environmental tolerance or a higher adaptation potential due to an increased genetic variability. Additionally, polyploids may benefit from genome downsizing which can favor a species' "weedy" behavior.

O7 - The genetic diversity of an invasive species determines its invasion success

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Biological invasions are a major threat to terrestrial and aquatic habitats. Due to global transport and climate change the dispersal and the establishment of invasive species into new habitats is

facilitated. It is widely accepted that population bottlenecks reduce the genetic diversity of immigrants. Since typically only a very limited number of propagules enter a new habitat the low genetic diversity is considered disadvantageous for the adaptation to the new environment. Thus, it is expected that an increasing genetic diversity of the propagules increases the invasion success. In the present study, we investigated the effect of the genetic diversity of the invasive cyanobacterium *Cylindrospermopsis raciborskii* on its invasion success into experimental phytoplankton communities. We tested 9 different strains separately and in combinations of 3, 6 and 9 strains in a competitive environment with low grazing losses. We found 1) all strains successfully invaded the experimental phytoplankton communities, 2) the invasion success differed between different strains and 3) compared to single strains, mixtures of strains exhibited a higher invasion success. Thus, we could experimentally confirm the hypothesis that genetic diversity facilitates successful invasions.

O8 - Hybridization in Fallopia species - new genes, new strategies, new effects?

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Fallopia japonica (Japanese Knotweed) is one of the worst invasive plant species in Europe and the United States. About 10 years ago the main path of invasion was vegetative spread and invasion strategies were very homogenous, as only one single large female clone existed and spread steadily – mainly along rivers and roads. During the last decade most invasive knotweeds found now belong to very powerful hybrids (Bohemian Knotweed, *Fallopia x bohemica*) and the process of spreading and regeneration changed. Within our study we quantified the importance of different taxa and their hybridization levels within the federal state of Rhineland Palatinate. We further quantified aggressiveness of spreading, biodiversity within as compared to outside the stands and site characteristics. Do the new taxa use even better strategies to invade new areas? From our data and literature we suggest that we will have much more “fun” with this new species group in the future.

O9 - Comparison of fitness components of invasive and non-invasive genotypes of *Aegilops cylindrica* under competition with bread wheat

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Mechanism leading to biological invasions can involve rapid evolutionary change in naturalized population. This could lead to local adaptation in invasive populations which could form one base for invasion success.

We used the jointed goat grass (*Aegilops cylindrica*) a close relative of bread wheat (*Triticum aestivum*) as a model to investigate differences between invasive and non-invasive genotypes. In its invasive range, the USA, *Aegilops cylindrica* is a prominent weed in bread wheat farming. This allows defining the invasiveness of a genotype by its level of infestation of bread wheat fields and provides the possibility of a stress treatment related to the invasion.

Within several experiments we used “invasive genotypes”, genotypes established in bread wheat fields in US and “native genotypes”, Eurasian genotypes not related to bread wheat farming. We measured several fitness components under different watering levels and levels of competition against bread wheat. In addition we performed pairwise competition experiments with invasive and non-invasive genotypes. The results were compared against a dense microsatellite dataset that allows determining level of genetic differentiation between and within the two groups.

In both experiments invasive genotypes of *Ae. cylindrica* tend to be bigger and produce more seeds. Comparison to genetic structure indicates a reduction of genetic variation during the introduction process and differences in phenotypic expression in invasion related fitness components in dependence of genetic relatedness. This supports the hypothesis that directed selection related to the colonization process led to higher competitive ability in invasive genotypes.

O10 - The role of insect herbivores in the interaction between *Tanacetum vulgare and Solidago canadensis* in a cross continent experiment

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Mechanisms underlying successful species invasion are still only partly understood. Invasive species may suffer less from co-evolved specialist herbivores or show increased vigour due to changed resource allocation in the invaded range. *Solidago canadensis* (Canada goldenrod; hereafter goldenrod) is native to the USA and invasive in Europe while *Tanacetum vulgare* (common tansy; hereafter tansy) is native to Europe and invasive in the USA. Both species often co-occur and suffer less from herbivory in the non native range. We investigated the role of insect herbivory for goldenrod and tansy in Germany, Hungary, and USA in a cross-site field experiment where species were grown in monoculture or with the other species. In addition, seeds of both species from the different origins were planted in a common greenhouse. There was little indication of competition between tansy and goldenrod based on plant biomass, height, flowering and shoot number. Both tansy and goldenrod showed higher biomass (T:125 vs. 16 and G:23 vs. 8 g) and height (T:115 vs. 75 and G:120 vs. 55 cm) in the invaded compared to the native range. In mixed plots, tansy showed higher biomass and more shoots than in monocultures, while effects for goldenrod depended on site (increase in Germany, decrease in USA). Herbivory for both tansy and goldenrod was higher in the native range. For tansy, insecticide application increased biomass, height and flowering in Europe and decreased them in USA. For goldenrod, insecticide treatment did not affect goldenrod performance despite high herbivory in the USA. In the common greenhouse, plants derived from the invaded range showed higher performance than plants from the native range, for both species. As there was no competitive suppression of native species, our experiment could not confirm the enemy release hypothesis. Instead there was indication for genotypic differences between plants from the native and invaded range pointing at adaptation to local conditions.

O11 - The invasive ladybird *Harmonia axyridis* carries bioweapons against native competitors

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The harlequin ladybird, *Harmonia axyridis*, has emerged as a model species for invasion biology, reflecting its remarkable capacity to outcompete native ladybird species when introduced into new habitats. This ability may be associated with its prominent resistance to pathogens and intraguild predation. We recently showed that the constitutive antibacterial activity present in its hemolymph can be attributed to the chemical defence compound harmonine (Röhrich et al., 2012).The invasive success of the species may reflect its well-adapted immune system, a hypothesis we tested by analysing the transcriptome of beetles challenged with bacteria or fungi. We identified more than 50 inducible AMPs (the highest number reported from an organism) belonging to seven different gene families (Vilcinskas et al., 2013). In addition, we discovered that *Harmonia* carries abundant spores of obligate parasitic microsporidia closely related to *Nosema thompsoni.* These microsporidia, although not harmful to the carrier, are lethal toward the native ladybird *Coccinella septempunctata*. We propose that intraguild predation, representing a major selective force among competing ladybird species, causes the infection and ultimate death of native ladybirds when they feed on microsporidia-contaminated Harmonia eggs or larvae. Consequently, these parasites are used like bioweapons against native competitors.

Vilcinskas et al. 2013: Invasive harlequin ladybird carries biological weapons against native competitors. Science, in press

Vilcinskas et al. 2013: Expansion of the antimicrobial peptide repertoire in the invasive ladybird Harmonia axyridis. Proc Royal Soc B 280 (1750), 20122113.

Schmidtberg et al. 2013: A switch from constitutive chemical defense to inducible innate immune responses in the invasive ladybird Harmonia axyridis. Biol Lett 9, 20130006.

Röhrich et al. 2012: Harmonine, a defense compound from the harlequin ladybird, inhibits mycobacterial growth and demonstrates multi-stage anti-malarial activity. Biol Lett 8, 308-311.

O12 - Seasonal effects of the invasive plant *Impatiens glandulifera* on biochemical soil characteristics and microbial community in beech forests

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The invasive plant *Impatiens glandulifera* is known to reduce the native plant species richness and to change plant-pollinator interactions in riparian systems. In the past decades, *I. glandulifera* started to invade forests disturbed by wind throw or by intensive management activities. Soil nutrient cycling and soil microbial activity are important factors determining the biodiversity, stability and productivity of forest ecosystems. We set up a field experiment to examine the effects of *I. glandulifera* on chemical and biochemical soil properties and soil microbial communities in beech forests. To assess the seasonal effects of *I. glandulifera*, soil samples were collected during the seedling, flowering and reproductive stage in plots covered with *I. glandulifera,*in plots where *I. glandulifera* has been removed and in control plots which were not yet colonized by the invasive plant. Our study showed that the invasion of *I. glandulifera* leads to significant changes in chemical and biochemical soil properties and caused shifts in the soil microbial community. Soil pH was reduced by 20%, whereas soil moisture and total soil nitrogen content were increased by 15-25% in plots with *I. glandulifera* compared with the corresponding values in control plots. The activities of the two soil enzymes β-Glucsidase and FDA were up to 60 % higher in plots with *I. glandulifera* compared with control plots. Furthermore, the invasion of *I. glandulifera* caused shifts in the composition of the soil fungal community, but not in the composition of soil bacterial. Overall, the effects of *I. glandulifera* on the assessed soil characteristics were more pronounced during the reproductive plant stage than in the seedling and juvenile stages. Our study demonstrates that the invasion of *I. glandulifera*has far-reaching and potentially long-term impacts on chemical and biological soil functions which are important for the structure and functioning of forest ecosystems.

O13 - Which attributes cause aquatic plant species to become invasive?

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Alien aquatic plant species cause serious ecological and economical impacts to freshwater ecosystems. In the last decades, particularly the ornamental trade caused an increased number of

aquatic plant introduction. Recently, it has been shown that alien aquatic species show a higher proportion of species causing ecological or economic impacts upon their habitats than terrestrial species. This is not only caused by the uniformity of most freshwater habitats, which allows aquatic plants to occupy very large ranges. There is some evidence, that some plant attributes play major roles for the invasiveness of introduced species. In this talk, the role of HCO_3^- - use mechanisms, regeneration capacity, propagule pressure, phenotypic plasticity, evergreenness and overwintering strategies for the invasiveness of the most invasive aquatic plant species will be discussed. Particularly the presence of a HCO_3^- - use mechanisms seems to be a major factor for the ability of submerged plants to form mass developments, even though the efficiency of these mechanisms are different between the species.

O14 - Expansion of invasive *Echinogammarus trichiatus* is mediated by restored semi-natural habitats in modified water systems

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The expansion of invasive species in water systems is driven by various environmental factors. Beside human-mediated transportation by ships e.g. in the ballast water, active spreading plays a major role in the invasion process. This active dispersal is mediated by the non-natural habitat structures commonly found in many navigable waterways that are modified by boulders or retaining walls. Additionally, these water ways are hydraulic disturbed systems by e.g. high ship-wave exposure. Thus, the resistance and adaptation capability of invasive species to such disturbances is commonly thought to be essential for the successful colonization of such altered ecosystems.

Currently, the invasion of the Ponto-Caspian amphipod *Echinogammarus trichiatus* is observed in the water system of Berlin, Germany. This species was first reported in the river Havel and the river Spree at the periphery of the city of Berlin in 2006. To date, only little information is available on the ecological requirements of *E. trichiatus*, but it is assumed that (analogous to many other invasive species) preferably systems with altered habitat structures are colonized. However, our continuous records of *E. trichiatus* in the river Spree since its arrival show that this species prefers shoreline section with semi-natural habitat structures. Such semi-natural structures mostly result from restoration efforts to reach the good ecological status or the good ecological potential according to the EU Water Framework Directive. Based on various invertebrate monitoring programs conducted in the water system of the city of Berlin, we were able to describe for the first time in this study the ecological habitat requirements and the active upstream migration rate of *E. trichiatus*.

O15 - Is intraguild predation by *Dikerogammarus villosus* on native and invasive species of importance in the field?

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The Ponto-Caspian amphipod *Dikerogammarus villosus* is one of the most invasive species in European waterways. By the invasion of *D. villosus* in central Europe a significant decrease in abundance of indigenous macroinvertebrates, especially of amphipod species, was recognized. Former laboratory studies revealed a strong intraguild predation (IGP) from *D. villosus* on other amphipods, which is thought to be the key factor of the observed displacement effects. However, to which extend IGP is of importance in the field was never investigated before. To determine the role of IGP in the field, we investigated different communities of coexisting amphipods under different conditions using stable isotope analyses ($\delta^{13}C$ and $\delta^{15}N$) in combination with genetic gut content analyses. First results clearly revealed a similar trophic position for *D. villosus* and the coexisting amphipod species and showed an overlap of their trophic niches. Likewise, genetic gut content analyses did not identify consumption of other amphipod species by *D. villosus*. This indicates that IGP is less important under field conditions and is not the key factor for the displacement of other amphipods. Consequently, the high reproductive ability and tolerance to different disturbance effects are more reasonable for the competitive strength of *D. villosus*.

O16 - From China with success - A new freshwater shrimp in NRW

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With a record in 2011 by a biologist catching fish in the Gillbach, an right affluent of the river Erft, *Neocaridina heteropoda* was found the first time in a German natural water body.

Originally native to East China and spreading to Japan and Taiwan this species was introduced by pet shops to Europe. Especially a red coloured variation is often found in European aquaria. Its tolerance against low water temperature made the invasion into German streams and rivers most likely. The Gillbach is a thermally polluted little stream with a “spring” recharged by cooling water of a brown coal power plant at Niederaußem and flowing into the river Erft near Neuss. It shows, comparably with the river Erft in the lower part, an increased temperature in winter.

This presentation will give an introduction into this species and, with a short key of identification, a comparison with the neozoan freshwater shrimp *Atyaephyra desmaresti*. Furthermore in 2012 and 2013 samples were taken documenting the dispersal in the Gillbach and potentially in the lower

river Erft. For a better understanding of dispersal strategies due to stream structure and gradient of temperature also some accompanying biota were collected and determined.

P1 - Invasional meltdown on abandoned urban areas: negative consequences for the native flora due to the facilitation of an exotic by a native herbivore

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Ecosystems that are heavily invaded by an exotic species often contain abundant populations of other invasive species. This process may reflect positive interactions among these exotic species and is termed “invasional meltdown”. Abandoned urban areas are often characterized by various species of invasive plants and herbivores that are coexisting with their native counterparts. We used this context to investigate whether the feeding of an exotic slug species (*Arion vulgaris*) on native plant species may facilitate growth of exotic plant species within the same community. We performed a mesocosm experiment with 8 plant species from the urban European flora (3 exotics and 5 natives) and the presence of four different combinations of gastropod herbivores: (1) no herbivores, (2) presence of *A. vulgaris*, (3) presence of *Cepaea nemoralis* (a native snail), and (4) presence of both gastropod species. We found that the exclusive presence of either *A. vulgaris* or *C. nemoralis* (treatment 2 and 3) did not alter aboveground biomass proportions of native or exotic plant species to overall plant community biomass. However, the presence of both herbivore species together (treatment 4) had an overall negative net effect on the proportion of native plant species (most notably on *Artemisia vulgaris*), and, in turn, a positive net effect on exotic plant species. Performance of the exotic slug was enhanced in the interaction treatment with the native herbivore. Our results indicate an “invasional meltdown” occurring in this system, although not due to direct, but indirect facilitative interactions between an exotic slug and exotic plants mediated by a native herbivore.

P2 - Alien and native plant species in natural and plantation forests of the Mediterranean Chile

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The landscape of Mediterranean Chile was dramatically changed during the last centuries by converting natural forests into agricultural land and then into plantations of exotic, fast-growing tree species. Especially the Biobío Region (latitude: 36° S) contains more plantations now than forests representing the natural vegetation. The large anthropogenic impact on the landscape facilitated the invasion of exotic plant species potentially threatening the high number of endemic species in this region and diminishing the chance of forest restoration.

In our study we analyzed the presence and frequency of alien plant species in 2 x 50 m transects along forest roads, on ruderal sites and inside forests differentiating young (< 5 years), intermediate (5 to 10 years) and old (> 10 years)*Pinus radiata*-plantations and still existing native *Nothofagus glauca*-stands. Our aim was to determine (1) the proportion of alien plant species within the species pool, to assess (2) a potential spread of alien plant species into the different forest ecosystems and (3) the survival of native species in plantation forests indicating a restoration potential.

Around 30 % of the sampled plant species were aliens with *Pinus radiata*, *Teline monspessulana*, *Hypochaeris radicata*, *Plantago lanceolata* and *Rumex acetosella* being the most frequent ones in the understorey. On ruderal and road plots the number of alien species was higher than the number of natives, while the opposite was observed on forest plots. When differentiated by forest type the proportion of native species was highest for *N. glauca*-stands (99 %) followed by old (60 %) and intermediate (77 %) *Pinus radiata*-stands. Only young *P. radiata*-stands had a lower proportion of native species compared to aliens (46 % vs. 54 %). Although, natural stands provide the most favorable conditions for native plant species, they survived in pine plantations as well and might contribute to a re-establishment of natural forests in the Biobío-region.

P3 - Differences in chemical traits between native and invasive populations of *Bunias orientalis* and relevance for herbivores

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One of the fundamental questions in invasion ecology, why some plants become dominant in novel environments, has been challenged increasingly, but still lacks a satisfying answer. Since plants in an exotic environment face other abiotic and biotic conditions than in their home-range, a shift in various traits, including chemical defences, has been observed repeatedly and may be partly explaining the success of the invaders. Several species within the family Brassicaceae have become invasive in novel environments. The Brassicaceae are well characterized by their dual defence system, in which glucosinolates are activated by myrosinases, leading to the release of toxic hydrolysis products. We studied shifts in chemical traits of the Brassicaceae *Bunias orientalis* (Turkish rocket), which is native to Asia and Eastern Europe but expanding its range towards Western Europe. While it is considered an exotic species, for example, in The Netherlands, it has reached invasive status in parts of Germany and the Czech Republic. We found that plants of the native, exotic and invasive range, grown under common garden conditions, can be well separated by their metabolic fingerprints. In particular, the composition of the glucosinolates differed tremendously in both quality and quantity between plants originating from different regions. We also found differences in enzymatic activities of myrosinases and proteinase inhibitors. The relevance of these differences in chemical defence for herbivore acceptance was tested in a field experiment.

P4 - New invasive plant species conquers our "stable" beech forests?

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About 10 years ago American Pokeweed (*Phytolacca americana*; deutsch: Amerikanische Kermesbeere) started spreading dramatically in forests in Southern Palatinate (Bienwald and surroundings). Initially invasion started from areas attacked by wind throw and bark beetles. Today, seed pressure (effective dispersal through birds) seems high enough to even allow for spreading in more or less undisturbed forest areas. Within our study we analyze the situation of the invasion process in Rhineland Palatinate including site factors, requirements for establishment and potential allelochemical mechanisms involved. Our study demonstrates that Phytolacca has a high capacity of invading to called "stable" undisturbed (beech) forests building impenetrable thickets, hindering natural rejuvenation processes of the trees.

P5 - Loricariidae an invasive fish family in Grijalva River, Mexico

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Since 1995 the *Loricariidae* fish family has been reported as invasive species in Mexico. The impacts of its presence in rivers and reservoirs include not only economic losses and fishermen unemployment due to out-competing local fish species, but also ecological consequences e.g. river shoreline erosion, degradation of water quality and depletion of endemic species. The Grijalva River belongs to an ecological zone with high biological and cultural diversity in Mexico, where until now the number of directly affected fishermen amounts to more than 12,000. In order to provide information for *Plecostomus* management and nonnative invasion prevention, this work is based on estimating the actual and potential geographical distribution of *Plecostomus* fish family in two steps: in the first phase, a geo-referenced dataset with occurrences of *Plecostomus* along the Grijalva River was created, climatic data was gathered and physico-chemical parameters of the water in the river were measured. The aim is to find variables that define the ecological niche of the species. The second phase consisted of creating a modeled geographic potential distribution range of

Plecostomus using statistical analysis packages (MaxEnt, Hyperniche). The results provide a basis to design a strategic prevention plan for *Plecostomus* invasion at a regional scale.

P6 - Effects of sampling techniques on population assessment of invasive round goby *Neogobius melanostomus*

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Decisions on sampling strategies and techniques are the first and most crucial steps in any fish biological investigation. A variety of fishing methods has been successfully applied to collect fish population data. Within the last two decades, abundance data of invasive Ponto-Caspian gobies have been collected from many habitats worldwide using different sampling strategies. However, quantitative comparisons are currently hampered by a lack of method intercalibration. In this study, a comparison of point abundance sampling (PAS) electrofishing, angling with two different hook sizes, and trap-based fishing was performed in a non-wadeable river to analyse their effects on catch per unit effort (CPUE) and population characteristics of invasive round goby. PAS-electrofishing was identified as the most effective (CPUE = 57 ± 4 (SE) round gobies min^{-1}) and least selective method in terms of size, feeding status and species composition. Angling had the second highest CPUE, but was more size selective and resulted in a higher proportion of males compared to electrofishing (overall sex ratio angling (f : m) = 1 : 0.92, electrofishing 1 : 0.65). Due to low CPUE (0.012 ± 0.004 (SE)) and low frequency-of-occurrence, minnow traps were least suitable for round goby population assessment. The results of this study suggest that a higher degree of standardisation and intercalibration is useful to achieve better comparability of population data of invasive round goby and other benthic fish species.

Session 34 - Carbon fluxes and turn-over in aquatic and terrestrial systems and their linkages

Chairs: Katrin Premke, Arthur Gessler

O1 - How does organic carbon make it from terrestrial to aquatic systems? A hydrologist's perspective.

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The transfer of organic carbon (OC) from terrestrial to aquatic systems is a major topic at the borderline of various disciplines. Surprisingly controversial perceptions and concepts exist concerning this linkage. This talk addresses some of the major myths.

The majority of water gets to the receiving stream or lake via the groundwater pathway. But that does not hold at all for OC. The mineral soil acts as a very effective filter of OC, thus separating OC of the rooting zone from freshwater systems.

Small headwater catchments often exhibit very rapid and tremendous increases of OC during discharge peaks. Only in some cases can these OC peaks be traced back to surface runoff or to contributions from tile drains. Thus the interflow concept has been suggested: During these events, lateral macropores in the topsoil fill with water which is then rapidly transferred to the streams above the groundwater table.

However, more detailed studies yielded clear evidence that the source of organic carbon during discharge peaks is the uppermost layer of the riparian zone close to the streams. Thus, the largest fraction of the catchment usually is decoupled from the freshwater systems with respect to organic carbon.

O2 - Greenhouse Gas emissions: integration of terrestrial and aquatic ecosystems in arable land

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The interaction between terrestrial and inland aquatic ecosystems plays an important role for greenhouse gas (GHG) emissions on the landscape scale. The transfer of carbon (C) and nitrogen between systems is driven by temporal and spatial changes of the boundary conditions. Understanding the contribution of each ecosystem and how they interact is relevant to characterize whether they act as net GHG source or sink. The aim of the LandScales project is to quantify the GHG emission across scales (from arable land to kettle holes) in a moraine landscape on the Northeast Germany. Our group investigates the hot spots for GHG emission in terrestrial and aquatic ecosystems. We have selected two different areas: 1) a highly eroded terrestrial side with a mesotrophic kettle hole and 2) a medium eroded terrestrial side with an eutrophic kettle hole. We quantify the GHG emissions of different landscape compartments: terrestrial, semi-aquatic (reed belt), open water and sediments. We assess the fluxes with different methods: chamber measurements (IRGA and GC) and Eddy flux technique. Additionally, to improve our understanding of the mechanisms, which regulate the variation on GHG emissions, we will perform microbiological- and chemical analysis of soil, water and sediments samples as well.

O3 - Microbial communities and carbon fluxes in a small agricultural catchment in south-east India

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Water management in South-East India is traditionally based on a system of thousands of interconnected ponds or small reservoirs filled up during monsoon and later on used for irrigation purposes. These ponds also trap sediments/soils, and thus organic carbon and nutrients from the surrounding catchments. Due to strong interlinkage of the aquatic and terrestrial ecosystems, continuously high temperatures (>25°C) and the water level fluctuation, these ponds are potential hot-spots for CO_2 and CH_4 emissions. As the ponds are common features within large areas of India they are potentially important regional greenhouse gas (GHG) sources and might play an important role on the global scale, where estimates of such processes are mostly based on data from the mid- and northern-latitudes.

In this study, the effects of soil organic carbon redistribution in an agricultural catchment in South-East India on GHG fluxes from a small reservoir were analysed. Additionally, microbial biomass and community structure were determined in the sediments of the reservoir and the surrounding soils by using phospholipid fatty acids (PLFA).Most changes in the total concentration of PLFA, an estimate of the microbial biomass, were observed during the months of monsoon, similar to the composition of PLFAs which varied considerably over time.

O4 - Dynamics, chemical properties and bioavailability of DOC in an early successional catchment

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The dynamics of dissolved organic carbon (DOC) have been intensively studied in mature ecosystems, but little is known about DOC dynamics and the significance of DOC as a substrate for microbial activity in early-successional catchments. We determined the concentration, chemical composition, radiocarbon age, and bioavailability of DOC along the hydrological flow path from soil solution to a downstream pond in a recently constructed catchment (Chicken Creek Catchment, Germany). Soil solution, upwelling ground water, subsurface water in an alluvial fan, and pond water all had high DOC concentrations (averaged 6.0 – 11.6 mg DOC L^{-1}), despite small carbon stocks in either vegetation or soil of the catchment. The mean ^{14}C age of DOC in upwelling ground water was 2600 to 2800 years. Solid-state CPMAS ^{13}C NMR revealed a higher proportion of aromatic compounds (32%) and a lower proportion of carbohydrates (33%) in upwelling ground water compared to pond water (18% and 45%, respectively). ^{14}C age and ^{13}C NMR spectra suggest that DOC was partly mobilized from charred organic matter inherent in the Quaternary substrate. In a 70-days incubation experiment, 20% of the total DOC was found to be bioavailable, irrespective of the water type. Origin of the microbial communities within the catchment (enriched from soil, stream sediment or pond water) had only marginal effects on overall DOC utilization. Overall, our data suggest that both recent and old DOC support microbial activity during early ecosystem succession, although a large fraction of the DOC is recalcitrant and eventually exported from the catchment once it has been mobilized.

O5 - Carbon transformation and microbial community structure across the terrestrial-aquatic interface of an early successional landscape

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Differences in water availability across land-water interfaces have been proposed as a key environmental factor accounting for spatio-temporal variation of C-transformations. We determined respiration rates, potential enzyme activities, and microbial community structure along a hydrological flow path from upland terrestrial to ephemeral to perennial sites in stream corridors of a man-made early-successional catchment. Soils and sediments were rewetted before measuring respiration to mimic hot moments of increased microbial activity during and after rainfall. Respiration rates and soil and sediment organic matter contents were generally low. Contrary to expectations, respiration rates of rewetted terrestrial soil and sediment from dry stream channels were similar to rates of sediments collected in the perennial channel sections. Bacterial community structure and potential enzyme activities showed disparate patterns and greater temporal (seasonal dynamics) than spatial variation (heterogeneity across the terrestrial-aquatic interface). Carbon turnover in the perennial channels was 4-8 fold higher than in ephemeral channels and terrestrial sites. However, extrapolated to one year and the whole catchment, stream channels contributed only 5% to total carbon turnover, 95% being due to soils during and after rainfall events. These findings suggest that hot moments are more important for C-transformation in early successional landscapes than hot spots.

O6 - Character of dissolved organic matter exports from agricultural areas - microbial soil processes versus autochthonous inputs in small streams

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Agricultural land use is of major importance on the global and local scale and significantly alters the conditions affecting organic matter processing in soils. With increasing agricultural land use shifts of dissolved organic matter (DOM) composition exported to headwater streams towards more labile microbial derived material has been reported. However, it still remains unclear whether this effect is due to allochthonous inputs from catchment soils, or originates from autochthonous production in headwater streams. Better knowledge of the compositional transformation of DOM would enable evaluating land use effects on downstream ecosystems, and to develop strategies for the reduction of the input of easily degradable material. We investigated DOM inputs from agricultural and

forested catchments of twelve small headwater streams with only negligible autochthonous production. Combining fluorescence analysis and size exclusion chromatography, we found that agricultural areas exported terrestrial, mainly humic, highly processed DOM. Surprisingly, this agricultural DOM was characterized by a low C:N ratio, with an elevated proportion of DOC components bound in form of non-humic high and low molecular weight substances. These findings rise the question whether the agricultural DOM is bioavailable, despite its high degree of microbial degradation, and thus likely fuels eutrophication in downstream reaches of river systems.

O7 - Different regulation of CO_2 emission from streams and lakes

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Greenhouse gas (GHG) emissions from surface waters are regulated by a variety of factors including e.g. nutrients, dissolved organic carbon, land use, and discharge. However, the impact of these factors might differ between streams and lakes, and the impact of climate change or land use on GHG emissions might be different in streams or lakes. The number of studies where CO_2 evasion was studied from both streams and lakes located in one catchment and including different land use forms are rather rare or only available from boreal catchments. It was the aim of our study to compare regulation mechanisms of CO_2 evasion from streams and reservoirs located in the same catchment in a typical temperate ecosystem. For this purpose we examined the seasonal variability in CO_2 concentration and emission from streams draining forests and agricultural areas as well as two pre-dams of a big drinking water reservoir. The investigated waters are located in the same catchment in the Harz Mountains in the temperate zone of Central Europe. We compare the CO_2 variability in the different systems regarding their regulation mechanisms and discuss findings with the actual literature.

O8 - Opposites attract: contrasting terrestrial carbon turnover and food web dynamics in the water and sediments of lake littoral zones

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Leaf litter is an important terrestrial carbon source in aquatic systems, but its processing and impacts on lake food webs remains largely unknown. Our objective was to study the leaf carbon turnover and its consequences for food web dynamics by focusing on the microbial metabolism in lakes.

Two approaches were used: 1) a field study simulating autumnal leaf litter fall, and 2) laboratory leaf incubations to evaluate bacterial activities in the sediments and on the leaves under controlled conditions.

In the lake, significantly increased dissolved organic carbon and nutrient concentrations were linked to an increased carbon turnover by bacteria in the water column. In contrast, the benthic bacterial community did not respond to the additional carbon source, whether in the lake or in the laboratory. Only the leaf-associated microbes directly incorporated the carbon of leached leaves on the sediment into their biomass. Most of the leaf carbon was therefore transferred via leaf-associated microbes and benthic macroinvertebrates to higher trophic levels. In contrast to the pelagic microbial loop, this benthic pathway represents a “shortcut” with fewer trophic levels, leading to reduced energy losses and hence increased energy transfer efficiencies.

O9 - Measuring dissolved greenhouse gases in peat-draining rivers with FTIR Spectroscopy

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Until recently, rivers have been considered as "passive pipes" in most carbon models, transporting particulate and dissolved matter from the land to the ocean. Recent research, however, suggests that rivers are highly active systems and an understudied source of greenhouse gases (GHG) to the atmosphere. In particular, fluvial transport from tropical peatlands, a globally important carbon pool, is not well quantified. Peatland degradation is suspected to increase carbon and nutrient loads to peat-draining rivers and to enhance the amount of dissolved CO_2, CH_4 and N_2O. We present a method to study dissolved GHG in rivers and their fluxes to the atmosphere with Fourier Transform InfraRed (FTIR) spectroscopy. It allows for the simultaneous and continuous measurement of major GHG (CO_2 and $\delta^{13}C$ in CO_2, CH_4, N_2O, and CO) with high accuracy and precision. Along with this, dissolved organic and inorganic carbon, nutrients and different parameters that describe water chemistry are measured, in order to resolve origin and fate of GHG in tropical peat-draining rivers.

O10 - Interplay between silicon availability as controller of plant litter properties and different functional animal groups affecting the carbon turnover in littoral

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The decomposition process of plant litter is very important for the carbon turnover. This process is controlled by litter properties, microbes and invertebrates. Recently, it was shown that silicon availability is linked to litter properties of grasses. Our experiments revealed that the carbon turnover during microbial litter decay was strongly influenced by the silicon availability during plant growth. Furthermore, we found a clear impact of invertebrate shredder on litter decay, whereas no negative effect of higher silicon and phytolite content was found. In addition we tested the effect of invertebrate grazers on litter decay. These grazers in turn are quite prevalent in some aquatic ecosystems. Nevertheless these grazers have been neglected so far, because of the commonly used mesh size by the litter bag technique, which is too small for the immigration of large snails. Consequently, a laboratory batch experiment was conducted to assess the effect of invertebrate grazer on aquatic litter decay. It was also tested whether silicon content affects the grazers, as was found for other grazing animals. It could be shown that invertebrate grazer have a significant effect on litter decay, by enhancing the cellulose degradation due to their cellulose enzymes.

P1 - Modeling carbon dynamics in small ponds

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Due to the complexity and the large number of the biogeochemical processes in small ponds and their adjacent arable areas, any modeling of carbon dynamics in kettle holes should take into account interactions between multiple elements, e.g. carbon, nitrogen, phosphorus, oxygen and other chemical elements. A significant fraction of these elements originate from agricultural areas and are transported to the ponds via wind or water erosion. This input is processed by phytoplankton, macrophytes, bacteria and fungi which are the key players for biomass production and decomposition.

Taking into account all these mechanisms and their interactions, we aim at setting up and testing a process-based model of carbon dynamics to obtain insight into the substantial short-term variations of these processes and their impact on long-term carbon budgets. The model will be based on the most prevailing processes. Model calibration and validation will be performed using data derived from spatial patterns and time series of water quality, macrophyte abundance, etc. as well as monitoring data of the ongoing LandScales project. In addition, sensitivity analyses will be conducted to determine the most sensitive parameters. This enables further exploration of the universality and robustness of the model and its parameters.

P2 - Applying isotope geochemistry to identify mechanisms regulating the aquatic-terrestrial carbon balance across scales in a moraine landscape

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Little is known about the mechanisms of carbon (C) storage and C spatial distribution in the terrestrial aquatic interface. To understand more about the direct interactions and potential feedbacks of C exchange in theses systems we focus on mechanisms regulating the C dynamics in the Quillow catchment (NE Germany): an arable landscape interspersed by kettle holes. We investigate specific C dynamics at three different spatial scales: (i) C degradation at the molecular scale, (ii) lateral C transfer in the kettle hole and in the aquatic-terrestrial transition zone and (iii) erosion and C/N dynamics at the regional landscape scale. For this purpose, this study heavily relies on the application of isotope labeling techniques as well as on the use of stable isotope natural abundances. We will conduct incubation experiments with physio-chemically separated soil organic matter (SOM) fractions with labeled sugar and measure the respired CO2. We will also monitor the quality of the DOC/DIC transported in the subsurface water of surrounding soils into two kettle holes as well as carry out a tracer experiment to trace flow paths in subsurface structures. Finally, we will create C/N isoscapes of soils, sediments and plants of a larger area (km^2) in the Quillow catchment.

P3 - Impact of carbon quality on carbon fluxes in stream ecosystems

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Freshwater aquatic systems can affect regional carbon (C) balances, and thus play a major role in the global C cycle. Although, running waters are among others key elements of agricultural landscapes, their role in the regional C budget remains unclear. Moreover, the importance of C quality in comparison to other factors (e.g. temperature) is indistinct. We investigate in a year round study 3 forestry streams, and 3 agricultural streams, situated in the North German Plain and the adjacent Poland. This setup provides two distinct catchment types and further two extremes of organic carbon qualities. We combine temporal assessment of CO_2 and CH_4 production in the streams using CO_2 and CH_4 sensors working with an Infrared Gas Analyzer (IRGA), with carbon quality aspects of the water and sediment to (1) characterize and compare the two catchment types, and (2) to link the C production patterns with the C quality aspects. C quality and C-turn over will be different over the year due to changing light regime and impact of primary production. Moreover, C-turn over in the streams impacted by land use is suggested to be higher than in those with forest catchment due to more labile compounds in the C source.

P4 - Aquatische Kohlenstoffdynamik in einem voralpinen Bach-See-Ökosystem (Österreich)

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Um den Einfluss extremer Wetterereignisse auf die aquatischen Kohlenstoffflüsse in einem alpinen Bach-See Ökosystem zu bewerten, werden in einem Einzugsgebiet (24,8 km², Österreich) basierend auf einem umfangreichen Messnetz die Kohlenstoffflüsse permanent in hoher zeitlicher Auflösung gemessen. Neben hydrometeorologischen Parametern werden vom Bachwasser, Porengrundwasser, dem Seewasser sowie von der Atmosphäre in einem 3-stündigen Intervall die Parameter CO_2, CH_4 und O_2 mit einer GreenHouseGas-Sentinel (Fa. Axys) online gemessen. Der Gehalt an DOC wird in einem 6 h-Intervall im Bachwasser und Porengrundwasser bestimmt. Mit einer YSI-Multisonde werden die Temperatur, Leitfähigkeit, der pH-Wert sowie die Trübung des Bachwassers gemessen (10 min-Intervall). Im gleichen Intervall werden an der tiefsten Stelle des Sees (34 m) während der eisfreien Zeit 3x täglich die Wassertemperatur, Leitfähigkeit, pH-Wert, Sauerstoff sowie der Gehalt an Chlorophyll-a in den Wassertiefen von 1 bis 30m gemessen.

Erste Ergebnisse der Datenauswertungen zeigen bereits einen deutlichen Einfluss von Niederschlags-Abfluss Ereignissen auf die Kohlenstoffflüsse im aquatischen Ökosystem „Oberer Seebach". Deutlich werden die Tagesschwankungen von Kohlendioxid und Sauerstoff im Bachwasser durch ein Abflussereignis unterbrochen, was darauf hindeutet, dass es kurzfristige Änderungen im aquatischen Prozessgefüge gibt. Welche langfristigen Auswirkungen Extremereignisse auf die aquatischen Kohlenstoffflüsse haben soll zukünftig geklärt werden.

P5 - Towards a metaproteomic approach to identify changes in aerobic methane oxidation in a lake

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The diversity and physiological state of microbial communities can now be analysed by simultaneous surveys of thousands of proteins detected and quantified in environmental samples. Application of this metaproteomic approach to natural systems holds great potential to gain new insights into microbial ecology, particularly by identifying characteristic biochemical pathways in mixed microbial communities of natural environments. The aim of this study was to detect specific microbial activities and key enzymes involved in the cycling of carbon in lakes, with a focus on the aerobic oxidation of methane. To this end, we examined water samples taken in Lake Stechlin at different depths and under varying oxygen conditions to characterize the metabolic potential of the methanotrophic bacterial community. Both forms of the key enzyme involved in microbial methane oxidation were examined, soluble methane monooxygenase (sMMO) and particulate (membrane-bound) methane monooxygenase (pMMO). One-dimensional SDS-PAGE was used in combination with metagenomic data to characterize distinct protein patterns and identify the associated biochemical pathways. The presented preliminary results are a first step towards estimating the expression patterns of methanotrophs in a natural ecosystem.

P6 - Soil CO_2 fluxes in short-rotation coppice on grassland using a low-impact planting technique

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Trials of short-rotation coppice (SRC) of poplar and willow on grassland with high groundwater tables were aimed at testing a low-impact planting technique in order to preserve soil carbon storage. Neither ploughs nor heavy machinery were used, no herbicides were applied, the grass was mowed every 3-4 weeks using a string trimmer or a cutter bar mower. Poplar (Max 1) and willow (Tordis) cuttings of 80 cm length were planted manually 70 cm deep using a drill auger of 32-40 mm diameter. Automated soil CO2 flux measurements were conducted using LI-8100A chambers, comparing soil CO2 fluxes within the plantation and outside the plantation. First results lead to the conclusion that the establishment of SRC on grassland without tilling and other intensive means of site preparation provide the possibility to grow woody biomass on grasslands without decreasing carbon storage, as it would be the case after ploughing or other soil disturbances when CO2 is released following mineralization of soil organic matter.

Session 35 - Ants, functions & services

Chairs: Yann Clough, Marcell Peters

O1 - Nutrient addition changes taxonomic composition but not trophic functions in a tropical leaf-litter ant assemblage

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In tropical forests, leaf-litter ants are abundant and diversified. From a functional point of view, they present a wide variety of diets and degrees of specialization that can be categorized into feeding groups. Carbon (C), nitrogen (N) and phosphorus (P) are limiting in the leaf-litter food web, from microorganisms to arthropods. In a previous nutrient addition experiment, we pointed out the differential response of ants according to their feeding groups but only in terms of density.

In the present study, we examined the response -in terms of taxonomic richness, and taxonomic and feeding group composition- of leaf-litter ants of an Ecuadorian premontane tropical forest to a 6-mo nutrient addition experiment (+CN, +CNP).

The taxonomic richness of the ant fauna was similar in control and fertilized plots, although the taxonomic composition changed significantly. While the overall trophic structure was unaffected by fertilization, taxonomic dominance changed within each group. *Solenopsis*, the dominant genus among omnivores in control plots, was numerically replaced by *Pheidole* in nutrient-treated plots. The same trend was observed among fungus and yeast eaters with *Cyphomyrmex* and *Myrmicocrypta*, among nectar and honeydew eaters with *Acropyga* and *Crematogaster*, and among predators with *Hypoponera* and *Strumigenys*.

Our results suggest that the relative abundance of ant taxa was differentially affected by fertilization. While the feeding functions were maintained among the ant assemblage with the nutrient supply, a taxonomic shift occurred within each feeding group, suggesting that the trophic functions are maintained in a changing environment, even if they are fulfilled by other taxa.

O2 - Can a single ant species matter? Leaf-cutting ants as emerging key players of neotropical forest transformation.

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The changing role of herbivores in human-modified ecosystems is still poorly understood. For example, the common perception of reduced herbivory levels in human-modified forests is challenged by the emergence of a small set of winner herbivores with potentially far-reaching implications for the functioning and progression of novel ecosystems. Here we present leaf-cutting ants (LCA) as powerful promoters of novel ecosystems, i.e. species that not only reach hyper-abundance following the conversion of continuous into fragmented forests, but in turn act as synergistic amplifiers of anthropogenic disturbance regimes. Compiling quantitative results on the multi-layered activities of leaf-cutting ants in neotropical forests, particularly in the Brazilian Atlantic Forest, we (1) demonstrate how they help to promote the proliferation of pioneer-type tree species *via* a combination of trophic impacts (herbivory and seed dispersal) and ecosystem engineering (nest mediated changes in microclimatic and edaphic conditions) and (2) try to elucidate the contextual attributes that determine/modulate the degree of their ecological release. In view of their omnipresence and ability to affect plant performance (from individual to assemblage level), LCA shed new light on the relevance of insect herbivores for the functioning and the successional trajectory experienced by novel tropical forest ecosystems.

O3 - Long-term ant exclusion in citrus shows a pervasive yet changing effect of ants on a Mediterranean arthropod assemblage

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Ants are important generalist predators in most terrestrial ecosystems. However, because many ant species are also aphid mutualists that defend them against their arthropod predators, the role of ants in agriculture has generally been considered to be negative for plants. In the present study, we report an 8-year ant-exclusion experiment from tree canopies in an organic citrus grove. Our main objectives were (1) to examine the influence of ants on the arthropod assemblage and (2) to examine whether ant exclusion increased the fruit yield of citrus trees via a reduction in aphid densities. The results of this long-term experiment can be divided into two periods with contrasting results. In the first period, the arthropod assemblage was only slightly affected by ants, except for a greater density of aphids in ant-excluded trees; however, fruit yield was also higher in ant-excluded than in control trees. In the second period, ant exclusion increased the abundance of most arthropod groups, and the previous positive effect on fruit yield was no longer observed. Detailed analyses of the heteropteran and spider assemblages revealed family-specific and even species-specific responses to ant exclusion that also varied over the years. Our findings show that the effects

of experimental manipulations in ecology can vary greatly over time and highlight the need for long-term studies to document species interactions.

O4 - Functional diversity in a Mediterranean ant community of an organic citrus grove - trophic positions and importance of trophobiosis

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Ants as generalist predators and mutualists of herbivores can play an important role in relative stable agroecosystems like plantations. The categorization of the diverse life strategies and traits into ecological groups like trophic levels is essential for a better understanding of food web structures and a better prediction of changes in communities. Stable isotope technology provides simultaneously detection of trophic levels and the ultimate C source of many species.

We studied a highly diverse Mediterranean arthropod community in an organic citrus grove in Tarragona, NE Spain, and analysed stable isotope contents (SI, $\delta^{13}C$ and $\delta^{15}N$) of 17 species of ants and 25 spider species together with dominating plants and aphid species to establish trophic guilds and detect seasonal changes. Combining direct contact observations between ants and aphids with SI data we aimed at disentangling the importance of trophobiosis in the food web and possible feedbacks at the functional diversity of ants. The results revealed significant differences between ant species spanning over a huge range in $\delta^{15}N$-values of at least 10.7‰ which is only comparable to a Peruvian tropical forest with a much higher species diversity. We found highly diverse trophic relationships between host plants, aphids and ants but many ant species do not exhibit the expected close relationship with trophobiotic partners. The analyses showed great seasonal variation in the isotopic signatures of some arthropod species, as well as the existence of various trophic groups and a wide range of trophic levels among ants and spiders. The possible role of intraguild predation and soil fauna as food resource besides the most commonly analysed green food chain is discussed. Our results support the hypothesis that the strong seasonality intrinsic to Mediterranean climate and the high heterogeneity of different plant resources and microclimatic conditions in the organically managed plantation are reflected by a notably high trophic diversity of the ant and spider community.

O5 - Considering traits improves prediction of pest predation by tropical ant communities

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Ants are a major predator group, but differ widely in body size and food preference. Most theoretical and empirical studies on predation use population densities to predict predation strength without regarding such species traits. It is widely unknown how these ecological traits affect predation by the ant community, and whether integrating traits into ecological models makes predictions more accurate.

We surveyed leaf herbivores, measured leaf herbivory and collected data of ant abundances, their body sizes and food preferences at baits in a 16 month ant fauna manipulation experiment, which has been established in Indonesian cacao plantations.

Higher leaf herbivore abundances increased leaf losses, while higher ant abundances reduced leaf damage due to herbivores. By correcting the ant abundance data for body mass and relative preference for protein we greatly improved the fit of the model explaining leaf loss. Similarly, leaf herbivores predicted leaf loss better when herbivores' biomass was taken into account. Our study shows that integrating ecological traits into ecological models can improve their fit and prediction strength.

O6 - The influence of altered temperature and the intensification of coffee cultivation on the functionality of ant communities

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Ants are abundant and important elements of terrestrial ecosystems and provide a variety of ecological functions. Habitat destruction, the intensification of agriculture and global warming may lead to a loss of ant species and thereby to a loss of ecological functions, whereas the interactions between global warming and land use intensification are one of the largest uncertainties of future biodiversity predictions. Furthermore, the relationship between the number or composition of species and their ecological functionality is still little understood, particularly in the species-rich ecosystems of the tropics. We analyzed the influence of temperature and land use intensification on coffee plantations in the lower montane ecosystems of Mt. Kilimanjaro on ant communities and their functional diversity. A combination of leaf litter sampling, bating, sweep netting and hand sampling techniques were implemented on a total of 17 study sites, including intensively used sun coffee plantations, shaded coffee plantations, agroforestry systems of the native Chagga culture and

lower montane rainforest. Functional diversity was investigated by morphometric measurements, stable isotope and observation data. We found an interaction between temperature and land use intensification for species richness and functional richness; furthermore species richness and functional richness were linearly correlated.

O7 - The role of ant attendance on biocontrol of *Aphis gossypii* on Okra: Agricultural implications in Cameroon

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Ant attendance of aphids has been well studied and it is widely accepted that ants protect aphids from their natural enemies, especially parasitoid wasps. The ant-aphid mutualism may also have consequences for other associated herbivores of the plant, but little information is available, in particular for agroecosystems. In Cameroon, West Africa, Okra (*Abelmoschus esculentus*) is one of the top two cultivated vegetable crops and the major Okra pests are the melon-cotton aphid (*Aphis gossypii*) and a yet unidentified chrysomelid leaf beetle, which may also transmit plant viruses. Local farmers spray vast amounts of pesticides to reduce these pests. In a country-wide field survey, ants of the genus *Pheidole* were found to actively tend *A. gossypii* on many Okra plants. The parasitism rate of aphids here is low, possibly due to a combination of frequent spraying and ant attendance. In a control greenhouse study we investigated the role ants play in the interactions between plants and beetles and the factors which can mediate ant influence.

O8 - Relative impact of ant and flying vertebrate exclusion on cacao plantations

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Arthropod herbivore regulation by predators is expected to be important in agro-ecosystems where primary productivity is high and food webs are simple. Intraguild predation, omnivory and trait-mediated effects make outcomes in terms of herbivore control difficult to predict. Furthermore, it is unclear how local management and landscape context affects the predatory function, as there are few studies investigating ecological contingency of top-down control.

In Central Sulawesi, Indonesia, cacao plantations are subject to substantial yield losses from pests and diseases. We hypothesized that: (1) both ants and flying predators such as birds and bats suppress herbivorous insects, thereby lowering yield losses; (2) the effect of ants and flying vertebrates are partially complementary; (3) management intensification such as the removal of shade trees and the conversion of nearby forest, on which many predators depend, compromises top-down control.

We tested these hypotheses using a full factorial exclusion experiment manipulating the access of ants, birds and bats in 15 cacao plantations covering gradients of shade tree cover and distance to natural forest. Yield, pest and diseases incidence were recorded every two weeks for almost 2 years. Arthropods were surveyed visually and collected by fogging at the end of the experiment.
Preliminary analyses show predator exclusion causes high reductions in yield (up to 50%) via multiple pathways involving sap-sucking and chewing herbivores. Effects of ants and flying vertebrates on cacao yield were partially complementary, but not as dependent on local management and landscape context as expected. We discuss the implications of these results for our understanding of trophic food webs and for the optimization of ecosystem service delivery in cacao agroecosystems.

P1 - Bittersweet sugars as indirect defence strategy

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There are numerous examples of mutualist interactions in which plants attract ants by providing food and/or shelter and benefit in form of reduced herbivore damage. For example many plants express extrafloral nectar secretion as indirect defence trait, which can be increased in response to herbivory. In general, these plants posses specialized structures, i.e. extrafloral nectaries, but we report herbivore induced sugar secretions of a plant that lacks these nectaries. We found that Bittersweet (*Solanum dulcamara*) secretes sucrose-rich fluids at the edges of wounds caused by chewing herbivores and in the field we frequently observed that various species of ants forage particularly on damage edges. We assessed ant attendance of several labroratory ant colonies on undamaged plants and plants that were fed on only two leaves by lepidopteran larvae. Whereas ants spent more time only on the sugar secreting damaged leaves, the number of visitations to leaves on damaged plants was increased irrespective of whether the leaves themselves were damaged or not. Thus, sugar secretions may provide systemic protection. This hypothesis was supported in a field experiment. We regularly applied a droplet of saturated sucrose solution on two leaves of plants in a natural *S. dulcamara* population and observed ant attendance and herbivore damage over a period of four weeks. Plants that received sugar droplets had increased ant abundance and suffered less leaf damage compared to control plants in close vicinity. Though we are still investigating the mechanisms and dynamics of *S. dulcamara*'s sugar secretions, our data imply that even plants without specific structures to secrete nectar can deploy ant mutalism via sugar secretions functioning as indirect defence.

P2 - Traffic rules on ant highways: Contact behavior influences the traffic on trails of the black-meadow ant *Formica pratensis*

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A constant influx of resources is essential to sustain ant colony growth. To facilitate efficient transport many species recruit workers on trails by extensive communication with other nest members. Mechanisms of information exchange include physical contacts and pheromone signals. Some species even establish road-like foraging trails (trunk trails) that are kept clear from vegetation by the ants. Under good foraging conditions the ant densities on these trails can be extreme, resulting in a high encounter frequency between in and outgoing foragers. Contacts with nestmates are often used for nestmate-recognition and foraging decision-making. This can reduce traffic speed and food intake at the individual level. For a better understanding of intraspecific communication and adaptations in ant traffic we investigated the foraging behavior in the black-meadow ant *Formica pratensis*. We analyzed the number of contacts as well as the mean contact time under different traffic densities. We found an increasing number of contacts with raising density but contact time remained constant over the observed density range. We also examined if ants perform a side preference when finishing contacts. Surprisingly our results indicate that workers of *F. pratensis* show side preference depending on walking direction and density regime. For low density inbound ants prefer to move to the right side whereas outbound ants leave contacts mostly to the left side, hence enhancing the probability of a contact rather than facilitating smooth traffic. We show that this "traffic rule" is responsible for a higher number of contacts than expected by random chance. Apparently in and outbound workers prefer communication over optimal foraging speed.

P3 - Investigating effects of yellow meadow ant mounds on physical and chemical soil properties of extensively grazed pastures

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Alongside termites and earthworms, ants are described as the most important soil engineers (Jouquet, Dauber et al. 2006). Their biogenic structures e.g. mounds, galleries and chambers and the associated soil environment extend horizontally and into depth ranging from centimeters up to a

meter, depending on the ant species under investigation. Because ants generate an environment inducing positive feedback for their colony development, their biogenic structures possibly have large influence on the landscape heterogeneity with regard to micro morphology, soil chemistry and physics and vegetation patterns. Within European grasslands the yellow meadow ant (*Lasius flavus*) is a common species, building up large colonies with an average population size of 23,000 individuals per nest (Seiffert 2007). Mature nests consist of a mechanically stabilized mound of mineral soil which can withstand grazing through large herbivores. In the study we aim to investigate the activity of the yellow meadow ant on physical and chemical soil properties and element fluxes in a Natura 2000 site, extensively grazed by sheep and cattle. The area is situated on sedimentary rocks of the Mesozoic era, partly covered by quaternary loess deposits. Soil types cover a sequence of Rendzic Leptosols to Cambisols deriving from bedrock weathering. With increasing loess thickness Haplic Cambisols to Luvisols are classified (FAO 1998). During summer 2013 we will establish four 50*50m permanent study plots differing in management and soil type. The spatial distribution of the mounds and areas of intensified ant activity will be surveyed within each plot. Subsequently, mounds of different development stages and ant uninhabited spots will be sampled for vegetation patterns and organic and inorganic soil compounds as well as fluxes of dissolved nutrients by suction plates. With this study we will contribute to a further understanding of ants as ecosystem engineers and switches for biogeochemical heterogeneity.

Session 36 - Facilitation in plant communities: recent advances and future directions

Chairs: Chris Smit, Santiago Soliveres, Fernando Maestre, Johannes Metz

O1 - The interaction of multiple (a)biotic stressors and herbivores drive the spatial organisation of salt marsh plant communities

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How multiple abiotic stress factors combined with herbivory affect interactions and resulting spatial organisation within plant communities is poorly understood. Complex combinations of multiple stressors exist in grazed salt marshes in Europe, where salinity and anoxia are thought to predictably decrease with increasing elevation. In this system, patches of tall plant communities (*Juncus maritimus* patches) are found alternating with short plant communities along the elevation gradient. Here we determined the underlying mechanisms and provide insight into the directional role large herbivores, soil macrofauna and physically defended plant species play in determining spatial interactions within plant communities. Along an elevation gradient we distinguished between inside and outside *Juncus* patches that were grazed and ungrazed by cattle. We measured differences in abiotic conditions (salinity and anoxia), conducted a comprehensive vegetation community survey and quantified the presence of herbivores (cattle, geese, hare) and soil macrofauna. With increasing elevation on the grazed marsh the local abiotic stress is strongly determined by the dominance of biotic drivers: inside *Juncus* patches the community is dominated by bioturbating soil macrofauna, while outside *Juncus* patches the community is dominated by large compacting herbivores. Plants intolerant to grazing (*Elytrigia atherica, Festuca rubra*) are probably protected by *Juncus* patches when large herbivores are present, while plant species adapted to stress (compaction and grazing) establish and become abundant outside of *Juncus* patches (e.g. *Puccinelia maritima, Juncus gerrardii*). On the ungrazed marsh grazing intolerant species become abundant outside *Juncus* patches (e.g. *E. atherica* and *F. rubra*) while the specialized grazing tolerant species *P. maritima* and *J. gerrardii* are absent. Our study shows that for an advanced understanding of interactions and spatial organisation of plant communities along stress gradients, it is crucial to include multiple stressors, consumers and their indirect effects.

O2 - Presence of arbuscular mycorrhiza shifts interspecific competition towards facilitation at low P availability

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Phosphorus (P) deficiency is an important stress for plants in grassland communities, resulting in a variety of adaptations for enhanced P uptake efficiency. One of the most important mechanisms is P uptake via arbuscular mycorrhizal fungi (AMF), which are of major ecological relevance as they may alter community structure by affecting plant-plant interactions. It has been shown that highly mycotrophic plants are able to establish efficient AMF mycelia by high carbon (C) allocation to the fungal partner, providing high mycorrhizal benefits at low P availability. Although seedling facilitation by established plants via common mycelial networks (CMNs) was observed in several studies, there is only poor information on CMN-mediated facilitation between plants of the same age.

We performed a controlled pot experiment, analyzing interactions between *Hieracium pilosella* and *Plantago lanceolata*, two common European grassland species with different degrees of mycotrophy. We used two different phosphorus concentrations in order to create a stress gradient.

Results on growth responses to mycorrhization confirmed a higher mycotrophy level for *H. pilosella* than for *P. lanceolata*. However, mycorrhizal benefits strongly depended on P-concentration: While at sufficient P-supply, there were negative and neutral effects on *P. lanceolata* and *H. pilosella*, respectively, P-limitation induced a shift towards positive feedbacks in both species. Results on relative neighbour effects indicated a mycorrhiza-mediated facilitative effect of *H. pilosella* on *P. lanceolata* at P deficiency.

Our results are in line with other studies that showed increased beneficial effects of AMF on host plants at P deficiency. Moreover, we conclude that mycorrhiza has the potential to shift a competitive plant-plant interaction towards facilitation via CMN at low P availability. Moreover, the differences between species-specific mycotrophy levels appear to be relevant for direction and dimension of CMN-mediated facilitation.

O3 - Plant-plant interactions in semiarid steppes as a function of the interaction between nutrients and water availability

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The outcome of plant-plant interactions in semiarid ecosystems may depend on specific and functional traits of the species involved and on the biotic and abiotic conditions prevailing in the area. Despite the large and increasing number of studies on plant-plant interactions, the relative role and the potential combined effect of the various factors that modulate plant-plant interaction are still being discussed. In steppe areas of southern Spain (Alicante), we examined the net effect of the interaction with mature *Stipa tenacissima* tussocks on *Olea europaea* seedlings in response to changes in the availability of two types of limiting resources: water and nutrients. Following a fully factorial experimental design, we planted *O. europaea* seedlings nearby and away from *S.*

tenacissima tussocks, and manipulated the availability of resources by independently applying inputs of water and nutrients (compost) to the planting microsites. We repeated the experiment on two sites with contrasting baseline availability of nutrients and water. Both nutrients and water limited seedling performance as both seedling survival and growth increased in the site and microsites with higher availability of these resources. All across the wide range of resource availability established, the negative effects of *S. tenacissima* on *O. europaea* largely prevailed against the positive effects. Increasing the availability of either water or nutrient resulted in a greater competitive strength of *S. tenacissima* on *O. europaea* seedlings, which was further enhanced when both nutrients and water were added.

O4 - Interspecific facilitation and critical transitions in arid ecosystems

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In this presentation we expand and combine insights from two major ecological theories that have until now largely advanced separately: the theory on critical transitions in arid ecosystems and the Stress Gradient Hypothesis. Climate change and intensified land-use impose severe stress on arid ecosystems, resulting in rapid degradation that is hard to reverse. To prevent such critical transitions it is crucial to detect early warning signals from ecosystems under stress. Increased 'patchiness' – smaller and fewer vegetated patches – is thought to be a signal indicating an imminent critical transition. Interspecific facilitation – positive interactions between plants – plays a crucial role in maintaining patchy vegetation in a stable state, but the exact mechanisms resulting in the breakdown of patches remain uncertain. Most recent synthesis on plant-plant interactions in arid ecosystems predicts a collapse in facilitation intensity at the high end of a drought stress gradient. This decline in facilitation strength has not been explicitly considered in model studies on critical transitions, but we propose that it has large consequences for the abiotic stress level at which a critical transition may occur. We postulate a new hypothetical framework for critical transitions in arid ecosystems along gradients of abiotic stress and facilitation strength. We propose that assessing the shape of the relationship between abiotic stress and interaction intensity, is crucial to predict critical transition thresholds. Moreover we highlight the effect of considering consumer pressure in plant-plant interaction research. We hypothesize that adding consumer pressure may result in even earlier and faster declines in facilitation intensity along drought stress gradients. We will present first results from experimental studies that will shed light on the relative importance of abiotic stress and consumer pressure in driving plant-plant interactions in arid ecosystems.

O5 - A global synthesis of drivers and effects of plant-plant interactions at both the pairwise and community levels

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Interactions between pairs of plant species are largely driven by environmental conditions, evolutionary relationships between interacting species and functional traits. However, studies addressing their relative importance are virtually non-existent. We conducted a field study to analyze the relative importance of –and relationships among– such drivers of plant-plant interactions in drylands at both global and regional scales. Functional traits were of primary importance and modulated the effect of the environment and evolutionary relationships. These results have important implications about how we understand changes in the importance of facilitation on plant communities (i.e., number of species depending on nurses), and how this importance change across environmental gradients. The latter, although widely discussed in current literature, have been never addressed before. In a second part, we synthesize current literature on the role of plant-plant interactions for species richness at the community level. We focused in this second part in studies conducted in drylands and alpine environments, which cover the vast majority of studies on plant-plant interactions at the community level. Our results serve as the first community-level test of the Stress Gradient Hypothesis (SGH) as originally proposed and its further refinements and alternatives. Our results highlight that an average of ~30% of the species within all the communities included were significantly associated to a nurse, illustrating the high importance of plant-plant interactions for the maintenance of plant diversity. However, this percentage varied

widely (from 0 to 100%) and we provide further insights on the behaviour of the importance of plant-plant interactions across a wide range of environments and community-types. We finally discuss when the SGH and its refinements and alternative hypotheses work, when they fail, and where should we focus future research

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O6 - Exploring the interplay between modes of positive and negative plant interactions

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Facilitation has received increasing attention in plant ecology over the last decade. Just as for competition, distinguishing different modes of facilitation (mutualistic, commensal or even antagonistic) may be crucial. We therefore introduce the new concept of symmetric vs. asymmetric facilitation and present a generic individual-based zone-of-influence model. The model simultaneously implements different modes of both facilitation and competition among individual plants via their overlapping zone of influence. Because we consider facilitation modes as a continuum related to environmental context, we integrated this concept with the stress gradient hypothesis (SGH) by exploring differences in spatial pattern formation, size inequality and self-thinning of simulated plant populations along a stress gradient in our model. The interplay among different modes of plant interaction creates distinctly varied patterns along stress gradients, with some of the patterns are supported by empirical observations. Our study demonstrates that the interplay between modes of facilitation and competition affects different aspects of plant populations and communities, implying context-dependent outcomes and consequences. The explicit consideration of the modes and mechanisms of interactions (both facilitation and competition) and the nature of stress factors will help to extend the framework of the SGH and foster research on facilitation in plant ecology.

O7 - Spatial gradients provide no good proxy for plant interactions under climate change: a long-term experiment

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Reliable climate change predictions need to account for the role of plant-plant interactions because neighboring plants likewise modify the biotic and abiotic environment. Yet, this is compromised by large uncertainty about strength and direction of future interactions.

Studying plant interactions along environmental gradients may provide estimates for their outcome under climate change. A large body of studies along spatial aridity gradients, for instance, showed that interactions change toward positive with increasing drought stress. They form a major argument in support of the stress-gradient-hypothesis (SGH) and imply that increasing facilitation might buffer against negative climate change impacts.

However, spatial gradients are questionable climate change proxies, among others because of confounding by additional environmental factors. Better suited but astonishingly rare are experiments applying strict climatic manipulations to assess future interactions.

The present study overcame this deficit and assessed interactions between annual plant communities and perennial shrubs in Israel under intensified drought conditions predicted by climate scenarios. We imposed rainfall manipulations (-30%, ambient, +30%) during 9 study years of varying rainfall in 3 different sites along a natural rainfall gradient. This threefold approach also allowed us to compare interaction patterns resulting from experimental manipulation with the spatial aridity gradient and between-year variation.

All three approaches yielded clearly differing patterns. Climate manipulations caused little change in plant interactions. In contrast, interactions turned toward positive with increasing site aridity, conforming to the SGH. Between-year variation, contrary to both above, caused stronger negative interactions in drier years.

We argue that plant-plant interactions may change little under climate change in our study system, unveiled by experimental manipulation. While this was unexpected judging from the spatial gradient, we will provide an explanation as to why spatial gradients may principally yield different interaction patterns than experimental manipulation and between-year variation, making them poor proxies for interactions under climate change.

O8 - Uncovering multi-scale effects of aridity and biotic interactions on the functional structure of Mediterranean shrublands

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Deterministic processes structuring natural communities, which integrate individual responses to the abiotic environment and biotic interactions (competition and facilitation) can be broadly separated into two categories: habitat filtering (trait convergence, HF) and niche differentiation (trait divergence, ND). Examining trait convergence and divergence at the community level constitutes an important first step to study community assembly. However, such an investigation does not suffice to infer the underlying mechanisms, as very different processes can lead to similar community trait distributions.

Here, we used a functional trait-based and multi-scale approach to assess how biotic interactions determine the functional structure of semi-arid shrublands sampled along a large aridity gradient in Spain. At the regional scale, we investigated functional differences among species to identify important traits for community assembly. At the community scale, we evaluated the relative impact of HF and ND on community structure. Finally, at the plant neighbourhood scale, we evaluated the impact of biotic interactions on community structure by investigating the spatial patterns of trait aggregation.

An important result from our study is that a shift from competition to facilitation appears to be trait-dependent. While patterns observed on some traits (*e.g.* height) supported the “SGH”, others showed contrasting responses to aridity. The trait dependency of the relationship between aridity vs. the outcomes of biotic interactions may explain contrasted patterns of competition/facilitation previously observed along stress gradients. Our result provide a mechanistic explanation helping to solve this issue: (i) competition and facilitation co-occurred within each community along the gradient but acted independently on different traits; and (ii) competition mainly impacted dominant species while facilitation benefited subordinate or rare species. By determining the functional structure of Mediterranean shrublands in response to aridity, competition and facilitation have strong impacts on the whole community composition and may have important implications for the functioning of arid ecosystems.

O9 - Can legume presence modify responses of temperate grassland species under annually recurrent pulsed drought and heavy rainfall events?

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Legume presence often play crucial role in grassland ecosystems, as their ability to fix atmospheric nitrogen may facilitate nutrition of neighboring species. However, little is known about whether legumes improve N availability and thus increase primary productivity of neighboring grassland species even in the face of extreme weather events. Here, we examine how the presence of a legume species modifies above-ground net primary productivity (ANPP) and nitrogen supply of neighboring grassland species under simulated, annually recurrent pulsed drought and heavy rainfall events. We do so by comparing responses of three grassland species with versus without legume presence over 4 years. Irrespective of weather manipulation, legume presence significantly increased ANPP of legume neighbors (species grown within a community containing a legume forb are called "legume neighbors") compared to non-legume neighbors (species grown within a community containing a non-legume forb are called "non-legume neighbors"). Legume neighbors had higher $\delta^{15}N$ values (which are closer to zero), higher shoot N content and leaf N concentration compared to non-legume neighbors, indicating a facilitative legume effect on neighboring species. Interaction between legume presence and weather extremes also had significant effects on ANPP of both legume and non-legume neighbors. Although legume presence led to an increase in ANPP of legume neighbors under heavy rainfall, ANPP of legume neighbors did not significantly vary under recurrent drought, potentially because of reduced N uptake ability of grassland species. We conclude that in contrast to heavy rain the presence of legume species could not effectively buffer against negative effects of extreme droughts on productivity of neighboring species in Central European grassland ecosystem.

O10 - Consequences of facilitation for the cushion plant *Laretia acaulis* (Apiaceae) in the Andes of central Chile: costs or benefits?

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By definition facilitation among plants is a positive interaction where at least one species involved in the interaction, the beneficiary, is favored in growth and/or reproduction. For the other species, the facilitator, the interaction can be positive, negative or neutral. Environmental stress may favor facilitative interactions, but whether these interactions are positive for the facilitator, and how this depends on stress factors, remains to be determined.

Cushion plants are well-known for their role as facilitator. Cushions are especially abundant in dry and cold conditions, where the compact form reduces water loss and convective cooling and allows the retention of organic material. These properties create favorable conditions for other plant species. In our study species *Laretia acaulis* in the Chilean high Andes, the frequency of facilitation is higher at lower altitudes, where conditions are dryer. We analyzed whether harboring other plant species represents a cost or a benefit for this species and how the balance between costs and benefits varies with altitude, i.e. on a gradient from drought stress to cold stress.

We studied the effects of increasing cover and biomass of beneficiaries on the reproduction of *L. acaulis* cushions at four altitudes (2600, 2800, 3000 and 3150 m; 40 cushions per altitude). The effects on growth and carbohydrate storage were quantified in a pilot study at 2800 m. A regression analysis shows little indication that the cushions' flower density depends on beneficiary abundance. However, fruit density does decrease with increasing plant cover at lower elevations. This may indicate a cost of facilitation, possibly due to competition for water at these dryer altitudes. Also, leaf biomass (per unit area) and starch storage in stems were lower in cushions with high plant cover (preliminary results, only for 2800 m, n=10). Additionally, at these low altitudes facilitation is more frequent, so that negative effects of facilitation may be extra pronounced here. Thus, positive interactions may not be so positive for the facilitator, especially if resource-related stress is high.

O11 - The interplay between plant spatial pattern and resource availability modulates plant-plant interaction intensity. A microcosm approach

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We used a multi-scale microcosm approach to investigate the effect of the interplay between water availability and plant spatial pattern on the sign and intensity of plant-plant interactions for a variety of Mediterranean dryland species. At the vegetation-patch scale, four seedlings of either different species (diverse patch) or the same species (monospecific patch) were installed in small-size (40 x 40 x 40 cm) microcosms, either tightly grouped as a single patch or separated as four distant individuals. At the slope scale, seedlings of three different species were established on diverse and monospecific (1 x 2 m) plots, arranged as either a coarse (six patches of nine seedlings each) or a fine (eighteen patches od three seedlings each) pattern. For varying conditions in soil water content, we assessed the net plant-plant interaction sign and intensity by comparing plant performance between individuals growing in monospecific patches and individuals growing in diverse patches. In both experiments, the outcome of plant-plant interactions largely varied between the species considered, and depended on the interaction between water availability and plant spatial pattern. In general, the most water-stressed conditions resulted in a higher intensity of negative interactions, particularly for larger plant patches.

O12 - The role of plant-plant interactions for colonization success in dry grasslands: application of a trait-based neighborhood model

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High propagule pressure is commonly assumed to be one of the most important factors that promote successful plant invasions. However, the extent to which high densities may facilitate colonization success depends on the intensity and nature of intra- as well as inter-specific plant-plant interactions. Facilitation and competition may hereby alternate in dependence of the colonizers' as well as neighbors' traits and in dependence of their spatial density. To investigate these interactions in a simulated colonization process we planted 400 individuals of archaeophytic *Geranium pusillum* at two dry grassland sites from which the species was previously absent. Juveniles of recorded size were placed at random but defined coordinates within ten 70 x 70 cm plots at each site, respectively. Survival, growth and reproduction of the individuals were assessed as response variables four and twelve weeks after planting. Within the plots as well as in a 50 cm buffer zone around them we also mapped the exact positions of all individual interspecific neighbors that exceeded 2 cm in diameter and / or in height. For all of these neighbors and for all *G. pusillum* individuals the average diameter at ground as well as at the height of their highest width and their height were recorded once in the study season. Clonal species as well as species occurring in constant densities within patches were mapped as polygons and size traits were measured for a subset of individuals or ramets. We analyze the data with novel trait-based neighborhood models that are implemented in a hierarchical Bayesian framework. The models explain variation in the *G. pusillum* juveniles' performance as a function of their initial size, size trait values of their neighbors and the neighbors' explicit spatial distribution.

The study helps to explain how establishment success of a colonizing species is determined by positive and negative interactions with intra- and interspecific neighbors and how these, in turn, depend on the plants' traits and their explicit spatial density. The study also tests the utility of trait-based neighborhood models for studying the role of plant-plant interactions during colonization processes in grassland communities.

O13 - Facilitation and tree-grass coexistence in arid savannas

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Many savanna studies have attempted to shed light on the mechanisms that support the coexistence of two, otherwise mutually exclusive, life forms: trees and grasses. Our current understanding rests upon a combination of stable and unstable dynamics depending on the amount of available water. In arid and semi-arid environments, trees and grasses are considered to be in a stable equilibrium having developed different niches to compete for the limiting resource, water. In mesic savannas there is enough water to sustain large tree populations and we would expect trees to dominate the landscape if competition was the only mechanism at work. Thus, it is believed that disturbances such as fire are necessary in preventing a shift to a closed canopy by controlling tree recruitment. .

Though the link between environmental stress and facilitation has recently been thoroughly investigated and there is a strong case for arguing that positive plant-plant interactions overpower competition under stressful conditions, the possible importance of facilitation remains an unresolved question within the savanna debate. We apply this stress-dependent facilitation reasoning into the study of tree-grass coexistence in arid savannas. We use a conceptual mathematical model of savanna dynamics which includes both competition and disturbances to investigate what happens at the drier end of the rainfall spectrum and we show that tree survival in arid conditions may be strongly dependent upon the presence of grasses through their role in preserving water in the system. Moreover, we demonstrate the importance of this facilitative relationship in extending the savanna biome boundaries under a combination of biotic (herbivory effects) and abiotic (aridity, heat) stressors.

O14 - Evolutionary aspects of facilitation

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One of the most pressing questions of current times is how organisms are able to keep-up with the on-going rapid human-induced modifications of the climate and environment. There is huge concern that species are going extinct when they are no longer able to adapt in time, with severe consequences for earth’s biodiversity and related ecosystem functioning and services. On the other hand, there is increasing awareness that evolutionary adaptations in species may go much quicker, and via other ways, than was thus far assumed. Ecological facilitation, i.e. positive species interactions, has been suggested as crucial driver for plant adaptations in changing environments, but this idea has thus far received very little attention in evolutionary context, and empirical evidence is scarce. In this talk I will give an overview of the evolutionary aspects of facilitation and present the outcome of ongoing experiments on facilitation in salt marshes that deal with this theme.

P1 - Positive interactions between moss and vascular plants? An example from a proglacial area in SE-Iceland

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Facilitation is a widely recognized process that shapes plant communities and is expected to be especially important in harsh environments. On the glacial outwash plain of Skeiðarársandur, a mosaic of early successional communities is developing. Diverging successional processes are clearly operating on the sandur. In the uppermost part, mosses form discrete patches of varying size on an otherwise sandy/gravelly plain. Moss patches may influence vascular plant establishment and growth by 1) acting as barrier and therefore trapping seeds more effectively than barren ground, 2) creating safe sites for germination or 3) improving growing conditions for vascular plants by modifying the microclimate and/or soil moisture retention.

To examine the potential roles of moss, we compared seed rain and seed bank in moss patches and surrounding barren areas. To test the effect of moss on vascular plant germination, establishment and survival we transplanted homogeneous moss mats into two sites with different substrate (fine vs. coarse) in the barren central part of Skeiðarársandur in 2010. A seedling transplant and sowing experiment with locally collected seeds started in spring 2011 to compare germination rates, seedling establishment and plant survival for five selected species (*Silene acaulis*, *Campanula rotundifolia*, *Luzula multiflora*, *Rumex acetosella* and *Betula pubescens*).

There was no significant difference in seed rain and seed bank size between moss patches and bare ground but most of the viable seeds were found beneath moss. Germination rate on the experimental sites was significantly higher in bare ground than in moss. Germination rate was higher on coarse substrate. Germination in the different treatments varied markedly between species, ranging from 0% to 56%. Substrate affected winter survival of seedlings which was highest on coarse substrate.

Our results indicate facilitation effects of the moss due to better seed survival in winter. Higher germination rate after winter leads to higher density and species richness of vascular plants in moss patches. Frost heaving did not appear to be strong, but might be an important factor for seedling survival. Our study shows the importance of facilitation in plant succession and emphasizes the widely underestimated role of mosses in ecosystems.

P2 - Interplay between facilitation and competition depends on abiotic stress and ontogenetic stage

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The most important causes for shifts between facilitation and competition are degree of abiotic stress and change in ontogenetic stage. The importance of these two factors in determining the interplay between facilitation and competition is well known. However their joint effect on the

outcome of plant interactions is still poorly understood, especially when a continuous gradient of abiotic stress is considered.

We evaluated the frequency of association of a woody perennial species, *Clusia criuva* Cambess. (Clusiaceae), with typical coastal dune species across a gradient of water stress and how this association affects the growth of juveniles and sub-adults.

The study area was a coastal dune region, where the sandy soil promotes severe water stress. One-year growth of all *C. criuva* within a 37 ha area, and their distance to the closest humid slacks were measured. This distance is a good surrogate for water stress, since the slacks are formed by proximity to groundwater.

Results showed that proportion of individuals associated with other plants increased with abiotic stress for both ontogenetic stages, but was always greater for juveniles. This indicates that plant association is progressively more important to guarantee survival or recruitment of plants as abiotic stress increases. Diameter growth of both ontogenetic stages and growth in height of juveniles showed a similar response. The benefit provided by association with other plant species reduces with water stress, but growth rate of associated plants is still greater than that of isolated ones, except at harsher conditions. Height growth of adults was not affected by association or abiotic stress.

Our study shows how frequency of spatial association and competition change with ontogenetic stage and can both increase with abiotic stress. This indicates that facilitation may become more common in harsher environments, increasing survival, but may also decrease in efficiency as competition grows more influent.

P3 - Plant interactions along a mixed gradient of drought stress and herbivory

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To better predict future responses of ecosystems to projected climate change, it is crucial to understand how plant-plant interactions change along stress gradients. For arid ecosystems many studies report an increase in positive interactions with increasing drought stress, while at the extreme end of the drought gradient, neutral or even negative interactions have been reported. The same relation – first an increase and then a collapse in positive interactions – has been reported along gradients of consumer pressure. However, the combined effects of consumer pressure and drought stress on plant-plant interactions are still very poorly studied. In this poster we present results from an observational and experimental study conducted in the south east of Spain. Along a gradient of consumer pressure, we performed observational transects to measure vegetation cover, patchiness, and plant co-occurrence patterns. We found significant contrasts in degradation and vegetation cover along the grazing gradient, with interacting effects between aspect and grazing. Moreover we found shifts in plant interactions; mainly tussock grasses shifting from being competitive to facilitative with increasing grazing stress. Moreover, we performed an experimental study in which sapling survival of a palatable shrub (*Anthyllis cytisoides*) was monitored at two goat grazing levels in three microsites; (i) under the canopy of a tussock grass patch (*Stipa tenacissima*), (ii) next to a bend-away *Stipa* patch and (iii) at an open microsite. We found clear differences in survival, with higher survival in the unbend tussock grass, but survival rates did not differ between the two goat grazing treatments, as current rabbit grazing seems to override the effects of prior goat grazing. Our study highlights the importance of supplementing observational co-occurrence data with experimental studies to be able to mechanistically understand plant-plant interactions at stress gradients consisting of multiple drivers.

Session 37 - Food webs in space - community ecology of island systems

Chairs: Michael Bonkowski, Werner Ulrich, Alexei Tiunov

O1 - Effects of habitat and resource quantity and quality on terrestrial invertebrate and bird communities

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One of the more tested relationships in ecology is the one between species number and area. While a positive relationship has found much support, especially in island systems, other factors that co-vary with area complicate interpretations of this relationship. Further, islands and other terrestrial systems receive spatial subsidies - often in the form of emergent aquatic insects - that may cause terrestrial community patterns to deviate from the predicted species-area relationship. In a freshwater-lake archipelago that is well characterized in terms of area, isolation, terrestrial plant communities (i.e. habitat heterogeneity) and plant primary production (i.e. resource availability), we surveyed terrestrial invertebrate and bird communities, and measured the input of aquatic subsidies, over two years, to test if area, habitat heterogeneity, or resource availability was able to predict patterns in terrestrial consumer species richness. While area was a strong determinant of both birds (positively) and terrestrial invertebrates (negatively), its influence completely disappeared once habitat heterogeneity and resource availability was taken into account. As such, our results suggest that habitat heterogeneity and resource availability (i.e. aquatic subsidies) are primary drivers of terrestrial invertebrate communities, which in turn influences the bird communities. However, even if prey abundance is an important driver of bird communities, we have other results suggesting that prey quality is more important than quantity to birds. Human impacts on freshwater systems may result in changed quality and quantity of aquatic subsidies, with likely consequences for terrestrial consumers. Therefore, rather than too much focus on habitat size, other factors such as heterogeneity, resource availability, and spatial subsidies, and human modification of these factors, should be simultaneously considered for a greater understanding of what drives terrestrial consumer (in particular bird) community patterns. This will also most likely result in more successful conservation and restoration efforts.

O2 - Short-distance aquatic subsidy and spatial compartmentalization of soil food webs: isotopic evidence

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Lateral links among adjacent ecosystems are among the main driving forces that shape the structure of trophic webs in terrestrial communities. In particular, emergent aquatic insects can transport energy, nutrients and limiting organic compounds from aquatic to terrestrial habitats. This "aquatic subsidy" is likely to be most important in small islands and in landscapes containing interspersed land and aquatic fragments. Estimation of the strength of lateral links between aquatic and terrestrial food webs was strongly facilitated with the introduction of isotopic methods. Organic matter (OM) in small eutrophic ponds is often depleted in ^{13}C due to a combination of several processes including the re-fixation of respired CO_2 and methanogenesis. In contrast, marine OM is strongly enriched in ^{13}C compared to terrestrial systems. Using these differences, we followed the flux of "aquatic" carbon into terrestrial soil-dwelling consumers in a range of coastal habitats. The trophic structure of the near-shore soil communities was usually strongly altered with an increased proportion of generalist predators (e.g. Carabidae and Lycosidae) that are the main acceptor of the aquatic subsidy. Nevertheless, it seems that the flux of carbon from aquatic to terrestrial systems of similar productivity is strongly limited in space and has a relatively weak impact on the energy budget of soil animal communities at the distances exceeding a few dozen meters from the coastline. The small-scale spatial compartmentalization of soil food webs is likely related to low mobility of many soil animals in combination with the dominance of local energy fluxes entering detrital food webs via dead organic matter. On the other hand, by studying a range of several neighboring biotopes we demonstrate that mobile litter-dwelling predators play a crucial role in integrating local food webs within and across neighboring ecosystems.

O3 - Intra- and interspecific niche variability in ground beetles on lake islands

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Classic theories on assembly rules and on food web structure are species-centred, so they largely ignore intraspecific variation. Trophic variation, however, might be of key importance for the understanding of the patterns at a community level. Here we study the variability of isotopic niche spaces of ground beetles and its consequences for the trophic structure of beetle assembly. Stable isotopes ratios ($\delta^{13}C$ and $\delta^{15}N$) were measured for 1156 beetles from 59 species inhabiting 20 island and mainland sites of the Masuria Lakeland in northern Poland. Carabid species came from three different trophic guilds. However high intraspecific trophic variability indicates the use of very different types of resources by conspecific individuals inhabiting different sites. In addition, more than 80% of species did not significantly differ in isotopic niche space. This high niche overlap

corroborates the view that resource competition is not a major factor shaping the composition of ground beetles communities. Future studies should take into account the complex trophic structure of beetle assemblages and explore the intraspecific niche variability of ground-beetles.

O4 - Systematic variation of cross-ecosystem feeding links and food-chain length on lake islands

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Aquatic-terrestrial food-web links have increasingly attracted the attention of ecologists in recent years. Pathways, impacts and mechanisms have been explored on beaches, river banks and lake shores and revealed a multitude of hidden connections and reciprocal influences between terrestrial and aquatic primary producers, consumers and predators. These ecosystem links have been rarely investigated systematically, i.e. the variation of cross-ecosystem consumption with a common factor is not well studied. As an example, the importance of the consumption of aquatic prey by terrestrial predators should decrease with the area of the habitat. In this presentation the unexpected complexity of this seemingly simple hypothesis is shown and corresponding stable isotope data from arthropod communities on man-made gravel pit lake islands are presented. Additionally we present data on food chain-length - area relationships from these lake island systems.

O5 - The trace elemental stoichiometry of lycosid spider species on gravel-pit lake islands

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We present data on the content and stoichiometry of 22 trace elements and metals in several lycosid spider species from man-made gravel-pit lake islands with Inductively Coupled Plasma Mass Spectrometry (ICP-MS) along with conventional stable isotope data of ^{13}C and ^{15}N. The trace elemental ecology and the potential use of ICP-MS data to solve ecological questions are discussed.

Session 39 - Biodiversity and Ecosystem Services of Urban Habitats

Chairs: Moritz von der Lippe, Leonie Fischer,

O1 - Biodiversity and Ecosystem services in urban regions

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Over half of the world's population now lives in urban areas and this proportion will grow steadily. Consequently, more and more people will depend on access to urban biodiversity and related ecosystem services. Urban growth, however, often conflicts with biodiversity conservation. The concept of ecosystem services provides a framework to link biodiversity conservation with the aim of strengthening human health and well-being in livable cities. Yet there is controversy about the role of biodiversity in contributing to different types of ecosystem services (e.g. species richness versus biomass). Another open question is about the necessity to consider the cultural diversity of urban residents as potential beneficiaries of ecosystem services. We therefore illustrate (i) an array of ecosystem services that are highly relevant in urban settings, (ii) discuss which categories of biodiversity are known or anticipated to provide ecosystem services and (iii) stress the need for linking biological diversity with socio-cultural diversity.

O2 - Diversity and specialisation of host-parasitoid interactions in an urban-rural interface

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Urban areas increasingly occupy more land and therefore replace natural ecosystems. However, depending on the degree of urbanization, some urban environments, such as gardens may also support biodiversity including bees, wasps and their parasitoids.

The goal of our study was to test the interactions between natural enemies and their hosts in an urban-rural interface. We exposed standardized trap nests for naturally occurring communities of bees and wasps and their parasitoids in Lüneburg, Germany. We used four habitat categories, with six replicated sites each: Urban gardens, suburban gardens, suburban rapeseed fields, and rural rapeseed fields isolated from the city. We address the following hypotheses: (1) The diversity of natural enemies decreases with increasing urban characteristics, leading to lower parasitism pressure in urban areas; (2) Parasitism rates are positively affected by the species richness of natural enemies and hosts; (3) Number of specialized natural enemy species increases in gardens compared to rapeseed fields.

Total abundance and species richness of natural enemies of bees were higher in suburban gardens compared to city gardens and rapeseed fields. Parasitism rates of wasps were higher in suburban gardens compared to rural rapeseed fields. Overall, rates of parasitism increased with increasing richness of their hosts and increasing richness of natural enemies, supporting findings of a positive diversity–function relationship in other trophic systems.

We conclude that suburban gardens enhance the diversity of specialized natural enemies of trap-nesting bees and wasps by harboring high host species diversity. This has important implications on trophic interactions in gardens and adjacent crop fields and emphasizes the importance of species diversity in an urban-rural interface for maintaining ecosystem services.

O3 - Urban arboreal arthropods: Effects of habitat amount and connectivity

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As cities grow worldwide, understanding effects of urbanisation on biodiversity becomes increasingly important. Loss and isolation of habitat play a major role and act at different spatial scales. The question is, on which scale the diversity of city-dwelling animals is affected.

We assessed Auchenorrhyncha, Heteroptera, Coleoptera, and Araneae on 36 independent birch trees (*Betula pendula*) in three Swiss cities. On a 500m-scale, study sites were surrounded by either a “green” or a “grey” landscape, with high or low amount of semi-natural habitat, respectively, measured as the mean Normalized Differenced Vegetation Index. On a 100m-scale, studied birch trees differed in their connectivity to other birches and the effect on birch specialists was investigated.

Preliminary results show that on the 500m-scale, a high amount of semi-natural habitat increased species richness and abundance of Heteroptera, Coleoptera and Araneae. The richness of Auchenorrhyncha, however, was similar with “grey” and “green” surroundings, and their abundance was even higher at sites in “grey” landscapes. On the 100m-scale, first analyses suggest that connected birches supported a higher richness and abundance of Heteroptera specialists than isolated trees, both in “grey” and “green” surroundings. The only Coleoptera specialist was more abundant on connected birches. In Auchenorrhyncha, we found no significant connectivity effect for richness of specialists, but their abundance was higher on connected birches in “grey” surroundings.

Our data show that both the amount of semi-natural habitat on a 500m-scale and the habitat connectivity on a 100m-scale influence arthropod communities, but their relative effects differ between arthropod groups. Although urban planners need to concentrate city development to minimize urban sprawl, to maintain arthropod diversity in cities it is essential to provide a sufficient amount of semi-natural habitat, as well as good connectivity between habitat patches.

O4 - A snapshot of the city: Composition of spontaneous vascular plant communities in urban green areas - a case study from Valdivia (Chile)

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In urban areas, natural and anthropogenic drivers of community assembly interact. This novel relation creates new assemblies of species, and may change the functioning of ecosystems. Recent studies have linked species richness and functional composition with socioeconomic factors. However, their influence on ecosystem functioning is a developing topic. Functional traits are useful approach to revealing the interactions between organisms and their responses to changes in the environment. Indeed, they can give information about shifts in ecosystem processes and characteristics. Both, functional and taxonomical composition can provide us with a better understanding of the biodiversity effects on community structure and ecosystem functioning. We assessed the effect of environmental and human filters on the taxonomic and functional composition of spontaneous vascular plants in public green areas in Valdivia. We used a stratified sampling method, based on four socioeconomic levels defined by Chilean government. Three habitats in urban green areas in each socioeconomic level were selected, and 20 m^2 plots were surveyed in the summers of 2010-1012. All spontaneous plants and relevant traits were recorded following the LEDA protocol. From the samples, we calculated leaf dry matter content (LDMC), and specific leaf area (SLA). We found that public green areas are highly dominated by exotic plants, with higher plant diversity in high-income neighborhoods. Nevertheless, functional composition shows no relation with social status as a driver. Changes in functional traits, between habitats and within species, were assessed. Our results suggest that anthropogenic conditions may influence the trait selection and plant community assembly, changing the trait composition and affecting the functioning of the ecosystem. Further research in urban areas will improve our knowledge about ecosystems functioning and will provide a better understanding of future changes in ecosystems.

O5 - Differential turnover along a land-use gradient in multiple dimensions of woody plant diversity suggests novel community assembly mechanisms

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One goal of sustainability plans in urban environments is to maintain or “improve” biodiversity. Biodiversity in this context is often poorly defined, but often assumed to focus on local diversity in remnant habitat and/or disturbed space. However, the substantial spatial disaggregation of the urban landscape created by variation in human valuation of land generates a complex template on which ecological communities respond. Basic ecological theory can and should be revised to understand how biodiversity is generated at multiple scales in urban ecosystems. The context for conservation and sustainability is that, in the built environment, how biodiversity is maintained is not completely understood without adequate understanding of how people value biodiversity within and among habitats, and how they interact directly and indirectly with the proliferation of preferred versus neglected species. A detailed analysis of 113 woody plant communities in Baltimore, Maryland, USA that include not just remnant and disturbed habitat but also those located on residential lots, commercial lots, parks and vacant lots, revealed significant variation in local diversity. But, more interestingly, these communities exhibited high variation in phylogenetic, taxonomic and functional trait turnover (i.e., beta diversity) among land-use types associated with stronger human influence. High rates of compositional turnover can be attributed to many ecological mechanisms, such as differential dispersal, environmental gradients, and local interspecific interactions. However, in the built environment, the differential magnitude among land-use types in turnover in all three components of diversity suggests a stronger human role. If maintaining biodiversity in the built environment is to be a goal in conservation and sustainability plans, then incorporating the human dimension into the mechanisms that both maintain diversity locally and generate it between habitats will be necessary to understand.

O6 - Who gets to live in the good neighborhood? Habitat preference by transient and resident coyotes in a rural-urban landscape mosaic in Rhode Island, US.

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Unlike other large carnivores, coyotes have been very successful in adapting to human landscape alteration. In the past 150 years, they have expanded their range from the Great Plains to most of

North America. In recent decades they have successfully moved into suburban and urban areas. In doing so, they have shown great flexibility in their behavior, utilizing new food sources, habitats and even shifting their activity to the nighttime to avoid humans. While coyotes remain almost invisible for most human residents, direct and indirect conflicts have made them a controversial carnivore species in urban North America. In order to avoid human-coyote conflicts, a good understanding of habitat preferences and movement patterns is necessary

Here we present results from costal Rhode Island, from a muti-year GPS telemetry study (2005 – 2013) on coyotes. We focused on two social classes: *residents* (individuals that have established a territory; n=25) and *transients* (individuals that have no territory; n=8). From high resolution land-use / land-cover data, the amount of land potentially available to each individual, and the amount that was actually used, was estimated. From the two, the preference for certain habitats was calculated.

Coyotes preferred habitat types that provide food, cover, and avoid human activity, like wetlands, brushland, or pastures, highlighting their importance in the landscape matrix. Significant differences in preference exist between night and daytime, underlining the coyotes' strategy of avoiding areas with greater human activity. More importantly, there are significant differences between residents and transients. We interpreted resident habitat selection as indicative of habitat preference because they defended it. Transients, having the need to avoid both humans and resident coyotes, more often utilize land-use types that probably don't reflect their habitat preferences and have a higher potential for human-coyote conflicts.

O7 - Ecosystem services in urban planning: opportunities and constraints in different planning landscapes

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Ecosystem services have recently gained much attention as a promising concept to more actively consider and plan for the varied benefits of the environment by including ecological, social and economic aspects. They are seen as a promising concept to redefine the relations between humans and nature and explore their multiple interactions in cities as social-ecological systems. Yet, to a make an impact on decision-making processes in cities ecosystem service related knowledge and conceptual understanding must spread from academia to urban planning arenas.

A cross-case comparison of Berlin and Seattle and Berlin was conducted in a two-tier approach to explore how the ecosystem service framework can enrich established approaches in spatial planning in urban areas. These cities and their surroundings represent differing geographies and policy frameworks, as well as different national discourses on ecosystem services.

First, the planning network influencing the spatial distribution and quality of urban green was mapped for both cities with reference to the broader context of the national planning cultures. Second, conceptual understanding of the social-ecological system expressed in planning and policy documents was compared to the ecosystem services framework and its underlying paradigms. The results highlight opportunities and constraints for applying the concept of ecosystem services in different planning landscapes. Multifunctional green infrastructure planning is suggested as a promising approach to further implementation of the ecosystem service concept.

O8 - Turning into town: how protected grassland biotopes relate to urban matrix parameters.

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Urbanisation is a major driver of biodiversity loss, and largely influences the fragmentation of grasslands at the urban periphery. While urban green spaces are known to include many grassland habitats, the extent and nature of urban land use types that harbour grasslands of special conservation interest are unknown.

We therefore combined information of the city-wide biotope mapping with the land use mapping of Berlin, and (1) determined the extend and the diversity of protected grassland biotope types within specific urban land use types, and (2) related the occurrence of protected grassland to urban matrix parameters. We exclusively worked at the habitat level, provided by the biotope type mapping and the legal protection status of each habitat patch. This allowed us to gain information that is independent from single taxa with varying habitat requirements.

With grasslands covering 5% of the land of Berlin, we found that 43% of this grassland area is assigned to protected grassland types. The majority of protected grassland (71%) lies on urban land opposed to 29% on agricultural land. We determined that airports and historic parks, which cover 2% of land in Berlin, contain one-third of all protected dry grasslands. The diversity of protected grassland is thereby highest in areas with a high variety of semi-natural structures, such as in areas with historic parks or in areas with rivers or lakes.

Our results within the region of Berlin demonstrate that urban green infrastructure and associated land uses can contribute to grassland conservation. Partially, urban land uses may compensate for the decrease of traditional grasslands in cultural landscapes outside of cities. With these findings, it becomes evident that grassland conservation is also depending on how residents and landowners can be involved in management practices, as most protected grasslands (57%) were found outside of conservation areas.

O9 - Ecological restoration leads to divergent trajectories of vegetation development in urban park forests after 15-20 years

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Local environmental quality is an urgent concern in urban areas, as both global urban populations and urban land area are expected to continue to increase rapidly. Municipalities are turning to ecological restoration of urban forests as a measure to improve air quality, ameliorate urban heat island effects, improve storm water infiltration, and to provide other social and ecological benefits. This study examines the long-term effects of restoration undertaken in New York City, NY, USA to restore forests in urban park natural areas invaded by woody invasive plants. In 2009 and 2010, I sampled vegetation in 30 invaded sites in 3 large parks that were restored in the early 1990s, and 30 sites in 3 large parks that were similarly invaded but had not been restored. After 15-20 years, vegetation composition and structure indicated that invasive species removal followed by planting resulted in persistent structural and compositional shifts, significantly lower invasive species abundance, a more complex forest structure, and greater native tree recruitment. Together, these findings indicate that successional trajectories of vegetation development have diverged between restored forests and invaded forests that were not restored. However, these findings also suggest that future composition of these urban forest patches will be novel assemblages in both cases. I present an urban perspective on the use of succession theory in ecological restoration, and present adaptive successional phasing as an approach to planning ecological restoration in the urban environment. By anticipating urban disturbances and incorporating ecological succession, management can be targeted as ecological processes unfold. Models of ecological restoration developed in more pristine environments must be modified for use in cities, and an urban approach to ecological restoration must value existing habitats in order to preserve and enhance urban biodiversity for both short-term benefits and long-term sustainability.

O10 - The role of nonnative tree species in biodiversity dynamics of urban wastelands

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Invasive pioneer trees such as black locust (*Robinia pseudoacacia* L.) are expected to exert a pronounced influence on plant assemblages and habitats such as nutrient-poor grassland vegetation. However, it remains unknown if the species turnover caused by exotic trees is different to the one of native tree species. Here, we compared the impact of spontaneous black locust and native silver birch (*Betula pendula* L.) stands on the grassland vegetation of urban wastelands in

Berlin, Germany, along 15 x 5 m transects, stretching from the open land into the forest. On plots outside, at the forest edge and inside the forests, alpha diversity and species turnover of the herb and shrub layer were analyzed. Moreover, the impact of the surrounding urban matrix on biodiversity was assessed. Species richness decreased consistently along transects with clearly higher diversity outside the forests. Furthermore, nonnative woodlands held significantly less species than native woodlands. The comparison of both forest types revealed a significant higher species turnover (Jaccard dissimilarity) along transects for black locust stands. The urban matrix influenced both the alpha diversity and species turnover of understory species communities. In particular, species turnover increased significantly with higher percentage of urban land uses (road, railroad and built-up area). This study's findings provide evidence that black locust during succession alters grassland vegetation to a higher degree than native pioneer species such as silver birch do –presumably due to nitrogen input and significantly more shady understory conditions. In addition, we show that this process is shaped by the urban environment.

O11 - Culture-driven and value assessment on urban forest ecosystem services: Hangzhou Case Study

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Abstract People-oriented new urbanization will become an important strategic choice for the sustainable urban development in the coming ten years in China. Due to the severe pressure from the economic transition, environmental degradation and population growth, humanitarian factor will have a non-negligible impact on the successful implementation of the new urbanization strategy. This paper made a case study for Hangzhou, the renowned historical and cultural city in China of Hangzhou, for which the urban forest humanistic values was assessed, the driven ways and the impact of ecological culture to the implementation of the new urbanization strategy was analyzed, and, the corresponding policies were recommended in the end.

Keywords Urban forest, Ecosystem services, Value assessment

Session 40 - Bridging scales with remote sensing

Chairs: Hannes Feilhauer, Pedro J. Leitao

O1 - Spectral - Spatial - Temporal? In search for the most helpful resolution for detecting semi-natural vegetation communities

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Within the remote sensing communities different properties of optical sensors can be used for the detection of vegetation communities. While very high spatial resolution data have the advantage of revealing habitat structures, hyperspectral information can supply valuable information about vegetation vitality as well as water and cellulosis content. Repeated data acquisitions within a vegetation period can supply valuable information about phenological development and phases. Still the discussion on the most helpful data-type is ongoing.

To provide some possibilities for benchmarking, we used different types of optical data for the well-known area of the Döberitzer Heide, a nature protection site west of Berlin. As former military training area, it also comprises large sections of open landscape. It represents a rich semi-natural landscape mosaic with several small-scale vegetation habitats. Dry sandy heaths, semi-natural grasslands, humid meadows, and wetlands dominate the flat open landscape.

We used imaging spectroscopy (AISA, HyMap), VHSR-data (QuickBird and WorldView) and multi-temporal data (RapidEye - 21 image stack from 2009 to 2011) to evaluate the possibilities of the different resolution-types. As calibration and validation samples we used spectral measurements and detailed mappings of 42 different plant compositions acquired between 2007 and 2011. Although the different data-types could be applied with more specific methods (e.g. ordination, time-series analysis, OBIA) we opted for a CART and a SVM classification for matters of comparison.

First results show that the different characteristics of the remote sensing data-types fit different classes, e.g. if the class can be defined by form and texture VHSR can be applied more successful. Thus a combination of the data and their results with ensemble classifiers could make use of the different advantages.

O2 - Is the sensor's view blurred? Effects of scale in vegetation mapping

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Remote sensing is a powerful tool for the spatial interpolation of field data sampled in plots. Image data are thus often used for vegetation mapping. The spatial resolution of an image is, however, related to a certain spatial scale and needs to be considered carefully to avoid a loss of information. In the present study we test how data from different sensors affect the representation of vegetation patterns in image-derived maps.

We used a complex of raised bogs, poor fens, sedge wetlands, and wet meadows in Southern Germany as test site. The vegetation was sampled in 60 plots in which we assessed the cover fractions of all occurring vascular plants and dominant mosses. These vegetation data were subjected to Nonmetric Multidimensional Scaling (NMS) to extract the main gradient in species composition. This gradient (i.e., the first NMS axis after principle component rotation) explained 56% of the variation in the vegetation data.

Airborne hyperspectral imagery was taken with the sensor AISA dual in 367 spectral bands and with 2 m spatial resolution. We used this imagery to simulate data of the spaceborne sensors RapidEye (5 bands, 5 m resolution) and Sentinel 2 (13 bands, 10 to 60 m resolution). Random Forest regression was used to relate the floristic gradient to the corresponding surface reflectance in each of the spectral data sets. The models fits ranged from R^2=0.74 for the AISA data to R^2=0.65 for the RapidEye data. The models were applied onto the image to derive a spatial prediction of the gradient scores. As a result of the differing spatial resolution, each map shows a different level of information. Implications for monitoring purposes are discussed.

O3 - From Point to Pattern - Spatial and Spectral modeling of *Hipparchia statilinus* occurrence probability on a former military training area

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Military conversion areas are increasingly recognized as important components to accomplish objectives of national biodiversity strategies. Thereby large and unfragmented sandy, heathland ecosystems forming habitats for rare and threatened plant and animal species such as the butterfly *Hipparchia statilinus*. Pointing out the limited access of military areas due to explosive contaminants, we here present an approach combining terrestrial mapping with remote sensing data to spatially predict the occurrence of *Hipparchia statilinus* on the basis of habitat characteristics.

For this purpose we conducted an area-wide sampling of presence-absence data covering a total area of 36 km² within a wide range of habitat factor complexes. We tested and compared two possibilities for habitat parameter extraction and spectral coherence analysis using spectral library information for the floristic inventory. On a first step vegetation categories were a priori defined and subsequently spectrally separated calibrating a random Forest classification that yields an overall accuracy of 92%. Vegetation categories are used as predictor variables within a logistic model framework to predict occurrence probabilities for multispectral worldview-2 image. On a second step the floristic composition was projected into a 3-dimensional ordination space using isomap. Calibrating spatial correlation functions Kriging interpolation were applied to aggregate habitat parameter complexes as well as distance measures in dependency on ordination space topology. PLS Regression was used to model ordination axes with hyperspectral signatures. Models were applied to AISA airborne images and habitat parameters were again correlated to presence-absence data with logistic regression.

It can be shown that ordination space aggregation results in a higher number of statistical significant habitat predictors, whereby overall logistic model framework shows a stronger predictive accuracy with a pseudo R^2 of 0.29.

O4 - *Jacobaea vulgaris* response to soil biota shown through hyperspectral reflectance patterns.

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Plants interact with a wide array of belowground herbivores, pathogens, mutualists, and their natural enemies that have important roles in driving spatio-temporal changes in vegetation (Clements 1963; Price 1984; Blomqvist, Olff et al. 2000; Bardgett and Wardle 2010). However, we often don not know the impact of soil organisms on a plants' success to occupy a new niche or its decline thereafter, monitoring is difficult. Yet these plant-soil interactions are of special interest in outbreak plant species (when time proceeds, soil biota can gradually exert natural biological control). In this talk we show the potential of visible and near-infrared spectral measurements to detect plant-soil interactions. We used *Jacobaea vulgaris* (ragwort), a native outbreak plant species in the Netherlands, in both lab and field conditions.

We examined how different soil microbial communities influenced changes in plant shoot spectral reflectance. Firstly *J. vulgaris* was grown in sterilized soil and living soil collected in fields that *J. vulgaris* grew. The soils' influence on shoot chemistry and hyperspectral reflectance patterns was analysed. In a second experiment soil microbial communities were modified to test which microbial communities could be the causality of the spectral patterns variation. A known chronosequence of abandoned arable-fields, which provided the season and succession temporal scales, was selected for a field trial. The potential of spectral reflectance to discriminate temporal variation was investigated in both plant organs: leaves and flowers.

With these experiments we can show that soil biotic communities can affect spectral reflectance patterns. The comparison between leaf chemical profiles and spectral reflectance patterns revealed similar capacity to discriminate plant species and the soil communities to which plants were exposed. Plant defence can vary with season and successional stage and reflectance patterns were also sensitive to such temporal variation. In the investigation of succession classes, 'Young' and 'Old' abandoned fields showed the largest differences in chemical and spectral reflectance patterns, especially if flowers were considered.

O5 - Bridging ecological scales in African savannas with airborne LiDAR and imaging spectroscopy

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Protected conservation areas in African savannas have long management histories of altered fire regimes and manipulated herbivore densities. Fire and herbivory are strong determinants of savanna vegetation structure and dynamics, and the influence of their individual and combined effects on biodiversity is of primary management concern. Field-based studies and monitoring programs are necessarily limited in spatial extent and resolution, and have often struggled to meet the information requirements of mangers responsible for large and heterogeneous landscapes. Over the past five years, the Carnegie Airborne Observatory (CAO, http://cao.ciw.edu), an integrated airborne LiDAR and imaging spectroscopy system, has conducted three extensive surveys over Kruger National Park (South Africa) to provide a time-series of detailed vegetation three-dimensional structure and dynamics. The fusion of vegetation structural attributes and dynamics (derived from LiDAR) with species information (derived from imaging spectroscopy) has enabled us to tease apart the relative influence of fire and herbivory on savanna vegetation, in different landscape types, and provide crucial quantitative measurements to inform biodiversity management. Here, we highlight some of our key findings that bridge scales from individual trees to whole vegetation communities, and facilitate the integration of science with policy-making.

O6 - High resolution, large areas: bridging scales by LIDAR-derived vegetation mapping of wetlands and grasslands

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Habitat monitoring requires remote sensing data covering the full studied area, while spatial resolution has to match the spatial scale of the vegetation patches and the inherent ecological processes. Therefore monitoring has proved difficult for sites where the extent is large but the vegetation pattern is fine. Non-forest habitats such as wetlands and grasslands are a typical case: in such areas, the state of the art involves processing of medium-resolution (2-50 m) multispectral images (compromising the spatial resolution) or manual interpretation of aerial photographs (which is very resource consuming).

We demonstrate two case studies where LIDAR data has been successfully used for meter or sub-meter resolution vegetation mapping over areas of 10-1000 km^2. The study sites are the reed wetlands of Lake Balaton and the hay meadows of the Sopron hills. LIDAR data consistently represents vegetation structure through the vertical distribution of measurement points, but also fine texture through echo width and radiometry through surface reflectance. This means that the information contained in the data is sufficient for automated classification with up to ten classes based on field data. In case of the wetlands of Lake Balaton, an expert-generated ruleset decision tree was used to map artificial surfaces and water, trees and shrubs, Carex, Typha and various health categories of Phragmites. In the grassland study, machine learning was applied to classify into non-vegetation surfaces, shrubs, wetland tall grass areas, herb fringes, and five hay meadow classes (abandoned, wet, dry, potential and confirmed lowland hay meadow). Both studies show total accuracies between 70 and 85% against independent references, which is comparable to the repeatability of field vegetation mapping.

Since LIDAR is a widely used mapping technique for large regions or even total states, it is a relatively accessible data source. The information content enables automatic classification, and processing is cost effective even over large areas. The resulting high resolution and full coverage maps are especially valuable for protected area management and habitat inventories, and can also be used as a basis for increasing the efficiency of fieldwork.

O7 - Airborne Laser Scanning for Natura 2000 habitat mapping and quality assessment

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Airborne Laser Scanning (ALS aka LIDAR) is an airborne remote sensing technique commonly used for mapping terrain topography and vegetation cover. It relies on distance measurement based on the travel time of laser pulses, from which terrain surface and vegetation canopy elevation are calculated for the measured points (10-20 pt/m^2). For many European states and regions, ALS data is already available or routinely collected.

Natura 2000 mapping and habitat quality assessment is compulsory for EU member states under the Habitat Directive, and involves a common scheme of mapping Species – Structure – Disturbances. The current state of the art is field mapping, occasionally/to some extent supported by the qualitative evaluation of satellite or aerial images. While this method is quite flexible, it raises questions of repeatability and is unfeasible over large or inaccessible areas.

The EU funded project ChangeHabitats2 aims at integrating ALS-derived indicators and maps for supporting Natura 2000 habitat mapping and assessment. Since the laser pulse penetrates the vegetation canopy, vertical vegetation structure can be measured, and even features below the forest vegetation. So far, automated deadwood mapping, forest canopy layer mapping and assessment of grassland habitats based on micro-topography have been established within the project. Automated mapping of sub-habitat patches in hay meadows is also proving to be feasible together with identification of artificial linear features (roads, tracks, power lines).

We plan to integrate these ALS-derived maps in a GIS system following the Natura 2000 habitat quality assessment scheme to provide spatially explicit estimates of habitat quality over large areas. While this system would never replace field mapping completely, it can help identify hot spots where field mapping is most needed and generally make Natura 2000 monitoring more cost effective, since habitat features and changes can be detected at a very fine scale.

O8 - Estimating biophysical crop properties by a machine learning model inversion using hyperspectral imagery of different resolution

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This study investigates how image resolution and phenology affects the quality of biophysical variable estimation of different crop types. Hence, several hyperspectral radiance images (400-2500 nm) of 1, 2 and 3 meter resolution were used to estimate leaf chlorophyll content (LCC) and leaf area index (LAI). The study area describes a climatic gradient that ranges from the Magdeburg Börde (130 meter a.s.l.) to the northeast of the Harz Mountain (450 meter a.s.l.), Germany. The 35 kilometer long flight strip is recorded on the same day at all three resolutions. Ground measurements were conducted simultaneously to the flight campaigns on selected crop fields.

The SLC model was coupled with the atmospheric model MODTRAN4 to build up a look-up table (LUT) of simulated at-sensor radiances. Subsequently, a support vector regression (SVR) was trained on the synthetic LUT to perform a pixel-wise inversion of the hyperspectral images. The machine learning algorithm is part of a broader inversion procedure for practical biophysical variable estimation.

In-situ measurements show varying LCC and LAI among the different types of crop. Topographical realities and soil properties have effects on LAI primarily. The achieved chlorophyll predictions are very good in line with the SPAD field measurements. The difference in image resolution might be too low to see high scale variance among the variable estimations. However, the standard deviation of the chlorophyll estimation decreases with lower resolution. Although the inversion was performed on a pixel-by-pixel basis the chlorophyll distribution across the field is rather uniform, so that smooth variations between neighboring pixel values can be observed. Predicted LAI values are higher than the ones measured in the field. It is expected that a coupled sensitivity analysis during the forward modeling approach will improve the prediction accuracy.

O9 - Monitoring habitat types with multiseasonal remote sensing and MaxEnt

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Monitoring of vegetation types becomes increasingly important due to global change and ongoing intensification of agricultural land-use systems. Programs of international interest like the Natura 2000 project (European Union Habitat directive) or the High Nature Value-Farmland (EU rural policy framework) demand an immense effort of mapping vegetation. Remote sensing offers a great potential for conservation monitoring.

In our study we use high resolution satellite data and field data to map the distribution of habitat types continuously over a broad area. Variations in the appearance of the very same vegetation type at different places and times are taken into account by including phenological information. Therefore we work with multiseasonal, multispectral satellite images and reference areas with their respective, current reflectance instead of spectral libraries that have been previously used for this task. The Maximum Entropy (MaxEnt) algorithm, often used in macroecology, has a great potential for identifying individual vegetation types in a matrix of complex vegetation patterns.

The field campaign took place in Southern Germany in early summer 2011 and 2012. We have sampled 186 plots concerning the vegetation belonging to four vegetation types according to the European Habitat Directive (Molinia meadows, degraded raised bogs, transition mires and quaking bogs, alkaline fens), or to High Nature Value-Farmland (five quality-classes). For each plot cover fractions of all dominant vascular plants and mosses were estimated and plots were classified. Information on the surface reflectance is available from the RapidEye sensor in 5 spectral bands. We used MaxEnt to relate the point based habitat type information to the corresponding reflectance. The final output consists of maps of occurring classes and measures of uncertainty. These maps will support an assessment of habitat distribution at regional scales and make future monitoring more time and cost efficient.

O10 - Mapping turnover in bird community composition with satellite spectral data

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Human-driven reduction in biodiversity is widely acknowledged, with direct impact on ecosystem functioning and provisioning of services. However, existing patterns of biodiversity and most particularly those of community composition turnover, or beta diversity, are little known. While Earth observation missions provide an excellent tool for describing these patterns, the structural complexity of biotic communities is usually difficult to characterise using data from existing satellite sensors. Also, multi-dimensional datasets such as multi-temporal or hyperspectral imagery are affected by severe multi-collinearity which presents further challenges for their analysis. In this study we develop a methodological approach which allows the direct use of multi-dimensional spectral data, as those coming from existing and forthcoming satellite sensors, for mapping

community composition turnover. This approach consists of coupling sparse canonical correlation analysis, capable of reducing the spectral dimension while keeping the useful information for describing the bird communities, with generalised dissimilarity modelling (GDM) for mapping species turnover. For this purpose we looked at the turnover of a steppe bird community into a shrub bird community along an environmental gradient of shrub encroachment, resulting from land abandonment, in a region in southern Portugal. A bird census was carried out in the field, using a stratified sampling scheme covering the different phases of vegetation succession. We further used a multi-temporal Landsat time series dataset as well as simulated EnMAP imagery, derived from geometrically and spectrally highly resolved airborne data, as predictors in our models. By using our approach, and when compared with a classical GDM approach which uses habitat maps as predictors, our models were greatly improved. Additionally, and by allowing the use of multi-dimensional datasets, our method showed a general improvement of the models and a great potential for mapping beta-diversity across large areas using satellite remote sensing data. Our results also highlight the potential of hyperspectral satellite data for the monitoring and assessment of ecosystems.

P1 - Do whole spectra discriminate species better than narrowband vegetation indices?

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The methodology of discriminating plant species based on their spectral characteristics is an important issue in hyperspectral remote sensing as well as in field spectroscopy. Field spectra of plant canopies are commonly used to train image classification algorithms, thus building the bridge between the leaf and landscape scale. Literature on the performance of those classifiers based on whole spectra is available. However, identifying spectral regions that allow the discrimination between plant canopies, sometimes even species specific, is difficult and sometimes not interpretable in a straightforward manner. Although narrowband vegetation indices have several advantages in comparison to whole spectra, these were only rarely applied for training of species canopy based image classification. Therefore, we tested whether classifiers based on narrowband vegetation indices or whole spectra performed better. For that, we have gathered a variety of field spectra data sets, collected in Portugal and Namibia (n>1000) and applied six different classification algorithms (SOM, PLS-DA, BRUTO, FDA, KNN, SVM) on narrowband and whole spectra data sets. The presented poster will highlight the differences between the two approaches, the methodological workflow as well as the results of the classification procedure.

P2 - Landsat time series analysis: the key to understand human impact in Chilean Patagonian ecosystems services

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Understanding human influence such as land use and land cover change on ecosystems at different spatial and temporal scales is the base to maintain and preserve ecosystems, the associated ecosystem functions and ecosystem services. The high amount of satellite images available at reasonable temporal and spatial resolution, such as from the Landsat mission, provides a valuable data source to research the dynamics of land use and vegetation change. We aim at a time series analysis of land use change in order to discriminate natural variability from human impacts. Our research area is the Valdivian temperate rain forest, located in the south of Chile. It is considered as biodiversity hotspot. The method used for the change detection focuses on an automatic preprocessing and land cover characterization of satellite images. We used all available images during the growing season (38 scenes) with a LT1 calibration level. Atmospheric correction was performed with LEDAPS routines, together with the cloud mask (Fmask), and a radiometric normalization (IR-MAD) to make the scenes taken from different conditions over the time comparable. The trajectory of land use change in the region provides the base line information to integrate biophysical and socioeconomic variables that drive land use change in the area. We hypothesize that the process of land use change in this area has led to degradation and to an increasing fragmentation of the native forest ecosystems. These modifications have potentially degraded the supply of ecosystem services in the province. The information derived from the land use change analysis will be essential to later on model the human impact and provide a scientific support to a sustainable ecosystem management.

P3 - Vegetation dynamics, carbon stocks and turnover rates in the Amazon - upscaling local processes with remote sensing time series

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Human induced land use and land cover change (LULCC) is one of the most important drivers shaping ecosystem processes and services. The Brazilian Amazon rainforest is a hotspot of LULCC, including deforestation, pasture and cropland expansion, land abandonment and re-cultivation. Its implication for the global ecosystems services, such as climate regulation has been discussed widely but the detailed processes are yet poorly understood. In terms of carbon sequestration and

mobilization, while most studies focus solely on deforestation and its related loss in above ground biomass they often ignore the role of vegetation dynamics related to the post-disturbance land use regimes, as well as that of below ground carbon. In this study we use remote sensing time series to link vegetation dynamics with soil carbon stocks and turnover rates. To cover historic and recent LULCC we make use of the full Landsat archive from 1984-2012 in the highly dynamic region of southern Pará, Brazil. Data on carbon stocks and turnover rates were derived from local field experiments based on a repetitive sampling design. Our results show that time series of Landsat data allow to distinguish vegetation dynamics relevant in shaping carbon stocks and turnover rates. This outcome highlights the possibilities to map the human-induced carbon dynamics by using time series of remote sensing data over wide areas.

Session 41 - Integrating ecological knowledge into conservation strategies under global change

Chairs: Tim Diekötter, Nina Farwig

O1 - Quo vadis? How satellite tracking can contribute to the conservation of the endangered Cape Vulture in Southern Africa

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Vultures provide important ecosystem services as they rapidly dispose and recycle carcasses, maintain energy flows in food webs and limit the spread of diseases. Yet, their populations are declining worldwide due to human land-use, electrocution, food shortage and persecution. In order to conserve endangered vulture species in the long-term, knowledge on the movement potential of individuals among remaining populations is essential. In this study, we investigated movement patterns and the connectivity among remaining colonies of the endangered Cape Vulture (*Gyps coprotheres*), a species endemic to Southern Africa. Using highly precise satellite telemetry, we tracked the movement of five first-year birds after leaving their natal colony. Preliminary results showed that the vultures are able to cross distances of several hundreds of kilometers and frequently visit other colonies and roosting sites. Our data can reveal the risk of power line collision, the usage of vulture restaurants and will allow the identification of colonies that are of specific conservation concern. Overall, the results of this study should help to develop conservation plans for the Cape Vulture in South Africa.

O2 - SRC-alley cropping: An integrative measure to sustain biodiversity and ecosystem services in agricultural landscapes?

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Agroforestry systems are currently discussed with respect to their potential as integrative biodiversity conservation measure in agriculture. An open question is whether agroforestry as cultivated habitat should be eligible as ecological focus area within the greening of the EU common agricultural policy. One type of agroforestry in Europe is alley cropping with strips of short rotation

coppice (SRC; mainly of fast growing poplar) for the combined production of food and energy. So far little is known about the importance of those systems for the effective support of biodiversity and ecosystem services in agricultural landscapes.

To increase our understanding of the functionality of SRC-alley cropping, we have examined the spatio-temporal exchange of ground dwelling arthropods between strips of SRC-poplar and strips of food crops in autumn and spring (2012/13) using directional pitfall-traps. In addition, we have compared the arthropod communities overwintering in soils of the alley cropping system to those of seminatural habitats (e.g. hedgerows, grassy fieldbanks) and conventional agricultural fields by taking soil samples in winter 2012. Collected specimens were sorted to relevant functional groups and for soil samples biomass of individuals was measured.

Ground dwelling arthropods showed a clear movement from food crop strips towards SRC-poplar strips in late autumn and early winter, indicating an exchange so far known for seminatural habitats. The abundance of arthropods in the soil of hedgerows and SRC-poplar strips were at comparable levels. Abundance of arthropods overwintering in crop fields integrated in the agroforestry system was significantly higher than on control fields. This indicates that SRC-alley cropping provides suitable hibernation-sites for arthropods. A comparison of the functional composition of the arthropod community will have to show whether agroforestry rather supports agents delivering ecosystem services than those delivering dis-services.

O3 - How much room for spiders? - A study on the home range of *Arctosa cinerea* at a Baltic Sea beach

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Baltic Sea beaches are highly attractive to tourists. What opportunities remain for the plants and animals at intensively used coasts? Our research group is developing a concept which should agree habitat and species conservation with tourism at Baltic Sea beaches. Thus we conduct several studies on biodiversity and on habitat requirements of plants and animal species.

The population size and movement behavior of the Lycosidae *Arctosa cinerea* was examined with a capture-recapture experiment at the beach of a conservation area near Stakendorf (Germany) from March to September 2012. In total 120 pitfall traps were established in three rows each within different distance to the shoreline (about 17m, 20m and 23m). Traps were controlled every second day and specimens were individually marked with a bee tag glued to their cephalothorax using a cyane-acrylate based adhesive.

The mean population size, analysed by using an adopted Jolly-Seber model (POPAN) with the program Mark, was 133 along the whole examination period. The estimated maximum population size was reached in May with 298 (±61) individuals. The Minimum-Convex-Polygon of *A. cinerea*, of individuals which were captured at least five times, was 178.6m² (±109.6) with a mean maximum distance within the polygon of 73.3m (±28.3). Spiders used the whole examined area along the beach, but the distribution of captured individuals showed significantly less catches in the lowest row (Kruskal-Wallis test).

Consequently we discuss the idea of closing the upper part of beaches to promote the development of arthropod populations at Baltic Sea beaches.

O4 - Extinction risk of saproxylic beetles reflects the ecological degradation of forests in Western and Central Europe during the last centuries

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In Europe, anthropogenic deforestation and the degradation of the remaining forests has lasted for millennia. Today, both processes are known to decrease biodiversity on a worldwide scale. To reduce the rate of biodiversity loss, it is necessary to know which factors threaten species and why susceptibility varies between species. Here, one widely used measure for extinction risk are Red Lists. To analyze the ecological background of current species extinction risk related to dead wood in Western and Central Europe we compiled Red List status, ecological traits, distribution records and a phylogeny of 1064 saproxylic beetles in Germany. This guild has been proofed as indicator group for anthropogenic degradation of forests worldwide and was studied only in Europe over centuries. Our linear models using generalized least squares with a correlation structure derived from the phylogenetic tree of saproxylic beetles revealed raised extinction risk for lowland and large-bodied species, species that rely on large-diameter dead wood, broadleaved host trees or cavities with wood mould as well as species that are confined to open canopy structures or that have a small geographical range. This pattern indicates that the current extinction risk of saproxylic beetles in Western and Central Europe is the result of modern forestry development of the last 200-300 years. To optimize conservation efforts in the temperate forests of Europe, we therefore recommend dead wood and overmature tree retention approaches, allowing more natural disturbances for open habitats, to increase the share of broadleaved trees, and to increase protected areas in lowlands.

O5 - The identification and mapping of important areas of plant diversity in Ireland

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There is a lack of knowledge on the distribution of important areas of plant diversity in Ireland and if protected areas are providing sufficient cover for these areas. We have started to address this knowledge gap by examining the distribution of locations containing rare and threatened plant species. Records of vascular plants from the island of Ireland were collated into a single plant distribution database. Rare and threatened plant species records were identified and mapped at the tetrad (2x2km) scale. We examined the overlap in spatial cover between national and European protected sites in Ireland and tetrads containing rare and threatened plant species. The proximity of undesignated tetrads to the protected area network was also examined.

The plant distribution database provided tetrad-level plant occurrence records for 30% of the island of Ireland and rare and threatened species were well-represented in these records. There were a significant percentage of tetrads with rare and threatened vascular plant species that did not occur within the protected area network. For example, over a quarter of tetrads containing red listed species are found outside of these protected areas. Our proximity analysis revealed an opportunity to prioritize undesignated areas for conservation action.

These results indicate that protected areas alone cannot protect the Irish flora and that conservation in the wider countryside (outside of protected areas) should remain an important feature of conservation policy. The work to date will be developed to enable the identification of Important Areas of Plant Diversity (IAPD) for the island of Ireland. A scoring approach will be used to rank tetrads according to the number and classes of plant species that occur within them, with the resulting highest scoring tetrads classified as IAPD. The identification method will be further developed to ensure that as many rare and threatened species as possible are represented in a network of IAPD.

O6 - School children collect seed removal data as citizen scientists - a win-win situation?

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Increasingly, the general public is involved in scientific data collection (citizen science), for example gathering occurrence data on bird, ants or plants. But so far, children are rarely actively involved in ecological research. As part of a large-scale study on seed fate along an urban-rural gradient, we choose schoolyards as field sites in urban and suburban areas and involved school children in our scientific research. Within this interdisciplinary project, we investigate (1) seed removal by ground-dwelling fauna, (2) assess the development and improvement of children's knowledge and awareness of diversity and (3) test whether children collect data on seed removal similarly to scientists.

Within the educational frame of the project, we gave interactive lessons on different habitats, native species and seed predation and dispersal as plant-animal interactions. The children also carried out exclusion experiments. Here, they set up different treatments with colored seeds (*Trifolium pratense* and *Avena sativa*) and access for specific seed-removing animal species. After two nights, the children counted seeds in each treatment and searched for missing seeds to distinguish between consumed and dispersed seeds. To assess whether data collection by children and scientists was similar, we tested all treatments in respect to response variables independently of the children.

First results show a significant difference of seed removal data collected by children and scientists, with children often missing smaller seeds. They usually had problems to concentrate and were distracted by their surroundings. However, when working in smaller groups and with some assistance by their teachers, the children were able to achieve similar results to data we collected.

We therefore propose that an environmental education project involving data collection by children is not only a successful path to enthuse children about environmental topics but also benefits researchers by generating large datasets.

P1 - Multifunctional benefits of urban grassland restoration

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In urban areas, restoration of grasslands can focus on multiple goals: (a) to create new habitat for flora and fauna, (b) to overcome dispersal limitations within the fragmented urban landscape, (c) to function as greening technique on bare land or on altered soils, or (d) to increase the visual effects of urban green spaces for humans, often in the context of designed landscapes. Whereas the flowers of target species represent additional food sources for insects, also human visitors are presumably attracted by enhanced biodiversity and flowering aspects in their all-day surrounding. After 5 years of grassland restoration on urban demolition sites we now go in detail on established flowering aspects and how they changed over time. For that, we combine data on vegetation composition of our experimental sites with data on flowering aspects of spontaneous and target species. Flowering aspects of target species are compared for different restoration techniques, and dominating colours over vegetation periods are analysed. For example, target species such a *Leucanthemum ircutianum* increased in their relative number of flower buds over the study period, with differences between restoration techniques. We discuss our new insights in the light of previous results, e.g., the general establishment success of the restoration techniques and positive trait combinations of target species for successful establishment. By integrating aesthetic components, benefits of grassland restoration can go beyond enhancing biodiversity of plants and animals within the urban matrix as conservation strategies could then be better communicated to other stakeholders, and independent from nature conservation strategies.

P2 - Do subsidized flowering fields support trap nesting Eumeninae in agricultural landscapes?

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Sown flowering fields are frequently used as a conservation tool for promoting pollen and nectar utilizing species in agricultural landscapes. To date, however, little is known about the influence of these newly created habitats on species requiring (i) additional arthropod prey and (ii) additional habitats for e.g. nesting. To examine the effect of sown flowering fields on prey-collecting and trap-nesting Eumeninae in a landscape context, we selected a total of 22 woody semi-natural habitats (i.e. potential nesting sites) in varying distances to sown flowering fields (i.e. potential foraging sites) in independent landscape sectors. Sectors additionally represented independent gradients in the proportion of arable farmland and grassland in the surrounding landscape. Two trap nests were placed next to the potential nesting sites and controlled weekly. Completed nests were collected for analysis in the lab and the number of nests and brood cells and the number and weight of prey items were recorded. In total, 289 nests with 1453 brood cells of eumenid wasps were recorded. The main prey stored in these brood cells was caterpillars with 5110 individuals in total. Numbers of nests per sector and the mean weight per caterpillar were negatively correlated to the distance to the flowering field. The diversity of the prey was positively correlated to the percentage of grassland and the mean weight per caterpillar was positively correlated to the size of the semi-natural habitat that trap nests were located at. Thus, flowering fields positively affected trap nesting Eumeninea by providing high quality prey thereby promoting nest building. In addition, trap-nesting Eumeninea were positively affected by surrounding shares of grassland, possibly indirectly by increased functionality of flowering fields. In conclusion, flowering fields benefit nectar and prey collecting Eumeninae if nesting habitats are present within suitable distances

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P3 - How to organize high-yield *Salix* plantations to increase pollinator attractivity?

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In the face of the Energy Transition in Germany, other sources for energy need to be found. Fast growing *Salix* and *Populus* plantations are alternative renewable resources. They can be harvested after few years and after re-sprouting be used in several cycles. While *Populus* is just providing the ecosystem service “provisioning” through biomass production, *Salix* additionally serves for “regulation” through feeding pollinators. It is one of the first flowering plant species of the season and therefore a major food source for pollinators in the agricultural landscape. For economic

purposes, *Salix* plantations are preferably monocultures of cultivars bred for highest vegetative yield.

In our study we questioned whether commonly used *Salix* cultivars differ in pollinator attractivity. We used twigs of five cultivars with different sexes. These twigs were synchronized for flowering time to ensure equal chances for each cultivar to get visited. After synchronisation the cultivars were transferred into the greenhouse and exposed to *Bombus terrestris* as a common pollinator. To determine the attractivity, visits per time unit were counted.

First results reveal that there is a preference towards male *Salix* cultivars, probably caused by the need for pollen in the *Bombus* colony. Two high-yield cultivars which are particularly vigorous were lowest in attractivity. This may be due to the breeding strategy which is selecting clones of high biomass production which consequently may exhibit less flower formation. Our results encourage for designing plantations that provide more than just one service in a future landscape that is dependent on pollination services.

P4 - Increase of energy maize production reduces farmland bird diversity

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Growth of energy crops as alternatives to fossil fuels for reducing CO2 emission will lead to large-scale changes of agricultural landscapes. Here we quantify the potential impact of such changes on the diversity of farmland birds in Germany by means of high resolution land-use scenarios. We focussed on the extension of maize fields, since 79% of the biomass used for biogas production in Germany is derived from this cereal grain. Based on data of the German Renewable Energy Act, we generated scenarios for the years 2020, 2035 and 2050, corresponding to a gradual increase of the maize production area from presently 2.6 to 2.9, 3.6 and 4.3 Mio ha, respectively. To test the potential of conservation measures, we additionally generated three alternative scenarios in which valuable farmland areas was excluded from being converted into maize fields. Effects on avian diversity were estimated by modelling the numerical response of nine species of farmland birds to the landscape changes resulting from the six scenarios. All species are part of the governmental indicator for the sustainability of land-use in Germany. It is shown that only the Northern Lapwing and the Little Owl would profit from the facilitation of maize production. Despite this partial positive response, however, the cumulative number of breeding pairs of all indicator species is predicted to decline by about 0.4 Mio under the conditions of the 2050 scenario. According to the alternative scenarios, protection of valuable farmland areas does not mitigate these negative effects. Considering that the loss of local populations is a much more sensitive parameter for biodiversity decline than the loss of species, these findings suggest that the trend for increasing the use of

energy crops to counteract global warming may severely conflict with the aim of conserving biological diversity.

P5 - The effect of trampling on the performance of the beach species *Crambe maritima*

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How much impact of tourism do beaches tolerate? Our research group is investigating the effects of trampling on beach plants. Findings are fundamental for the development of a concept which should agree habitat and species conservation with tourism at Baltic Sea beaches. First we conducted vegetation relevés as an initial analysis of the touristic impact on plant diversity on 15 differently used Baltic Sea beaches. To consider the sea-land gradient, beach sections were divided into ten transects with six 4m² plots each in different distance to the shoreline. Results showed that already a closed upper beach area can significantly promote typical beach plants of the Cakiletea-maritimae and the Honckeny-Elymetea.

Furthermore, we determined the effects of trampling on the performance of *Crambe maritima*. We planted 108 individuals of *C. maritima* on three different Baltic Sea beaches and treated them with 0, 1 and 2 steps $d^{-1}m^{-2}$. We measured plant growth (PG), leave growth (LG), number of leaves (NL), chlorophyll content of leaves and fitness of photosystemII. Additionally, we documented important habitat changes such as sand burial and flooding events. We applied Generalized Linear Mixed Models to analyse the effects of site and treatment on the performance of the individuals. With a standard ANOVA we tested each dependent variable against the factors site, measuring date and trampling intensity. Results revealed that differences of the site conditions were the dominating factor for the performance of *C. maritima*. Nevertheless, a significant reduction of all values for above ground biomass (PG, LG, NL) and for chlorophyll content of leaves due to trampling intensity could be detected. Lost leaf area was not replaced by an increase of leaf production. The fitness of the photosystemII was just affected by site and time but not by trampling intensity.

Based upon these results, more progressive ideas for spatial planning on Baltic Sea beaches to avoid trampling on sensitive plants are discussed.

P6 - Towards natural beech forests: Do allochthone spruce stands affect the potential of soil seed banks?

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In temperate forests, soil seed banks are to a large extent composed of light demanding successional plant species and of a small amount of short-lived seeds of the closed forest herbs. Apart from small close-to-virgin beech stands, the Kellerwald-Edersee Nationalpark is characterized by a large proportion of non-dissected, near-natural beech forests. In addition, there are allochthonous Norway spruce stands in the phase of re-developing back into natural beech stands.

The present study wants to shed light on the composition of the soil seed bank of near-natural beech stands. Next, we question as to whether spruce stands of about 100 years of continuity do affect the beech seed bank. It is known that spruce may severely change soil chemistry, especially pH, and biotic conditions and thus may impact both seed bank and recent vegetation.

Therefore, three pairs of adjacent near-natural and spruce stands were chosen, soil samples taken randomly and transferred to the greenhouse for conducting the seedling-emergence method (dt. “Auflaufmethode”). Soil samples from the spruce stands were shown to be lower in pH than the adjacent beech soils.

In the ongoing study, we are analyzing the soil seed bank by determining the emerging seedlings and classifying them according to available data bases. Next, species diversity and turn-over will be assessed. First results will be presented and discussed.

The data are expected to estimate the potential of the soil seed banks as sources for providing natural forest herb layers in the re-naturalized beech forests.

P7 - Towards natural beech forests: Performance experiment with beech seedlings raised on different soils

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In the Kellerwald-Edersee National Park large forest areas develop towards natural beech forests. Apart from close-to-virgin beech stands, the development starts from near-natural beech forests as well as from allochthonous Norway spruce stands. Spruce stands breaking down because of age, windbreak and bark beetles seem to support self-driving reconversion, but spruce could have affected soil chemistry, water availability and mycorrhizal communities thus negatively influencing the natural regeneration of beech.

To test this hypothesis, three pairs of adjacent near-natural beech and spruce stands were chosen. The stands with about 100 years of continuously grown spruce were lower in pH than the soil from the beech stands. From each of the six stands, 20 soil samples were randomly taken, directly transferred into pots and brought to the greenhouse. Seeds have been sown into the pots.

In ongoing studies performance and relative growth rates will be measured. After eight weeks of growth, half of the seedlings will be harvested and monitored for presence or absence of ectomycorrhizae. The other half will be subjected to drought stress measuring the same variables.

First results will be presented and discussed for self-driving reconversion of spruce stands into natural beech forests.

P8 - Does a diversity of regeneration strategies enhance the desired species diversity in mountain meadow plant communities?

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Two large-scale regeneration projects of low mountain meadow plant communities in the region Osterzgebirge/Saxony have been entering their second phase now. Hence, an extended time scale is added to the large spatial dimension, converting both projects into long-term conservation research areas.

The BfN Testing and Development Project (E+E) near Oelsen comprises 200 ha embedded in a 600 ha FFH-conservation unit and first data sampling began in 2001. The BfN-Large-Scale Conservation Project NSGP "Bergwiesen im Osterzgebirge" covers 750 ha and has been monitored since 1996. The latter area is benefitting from application of successful measures documented at the first site, since a close cooperation facilitates a fast transfer of experiences.

This year, the new research period at the E+E site will start. Many regeneration measures have been put into practice only after the first funding period, e.g. liming, removal of topsoil, opening of the grass sod, hay transfer. Have these methods been successful and which measurement combinations are most promising? For how long and at what costs should we try to conserve or re-establish rare species in their last refugiums in the midst of an increasingly intensified agrarian landscape? An overview based on the analyzed data of the past years will be given in the presentation as a starting point for a fruitful discussion on regeneration strategies in complex landscapes such as the Ore Mountains.

P9 - Oil palm development in Southwest Cameroon - a new threat to biodiversity and rural agroforestry systems

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Rising global demand for edible oils and biofuels led to a rapidly growing market of palm oil in the last decades. As a consequence, rural agroforestry and natural forest ecosystems are facing a substantial threat caused by land use change. Now that wide areas of Southeast Asia have been converted into plantations, the oil palm development started to emerge rapidly into other tropical forests regions conveying its associated impacts on socio-economy conditions and environment. Recent activities in Cameroon indicate that oil palm production will play a major role in deforestation and livelihood structures of rural communities in the African tropical forest zone. An American agribusiness company leased a 99-years concession for the establishment of an industrial oil palm plantation of more than 70,000 hectare in the Southwest region of Cameroon and already built up nurseries for oil palms. This planned project is located in the heart of the Gulf of Guinea Forests, an important centre of endemism, constituting the largest continuous forest block of the whole West African Forest biodiversity hotspot. This region overall harbours an exceptionally diverse species pool and a traditional agroforestry system primarily based on smallholder farms, embedded in a mature forest matrix. We describe observed developments, give an insight into the international opposition against the project, question the practices of the plantation promoters and dispute their assertions. This case study illustrates the urgent need for unbiased scientific studies with systematic approaches which are indispensable in the context of environmental and social impact assessments to protect vital local communities as well as threatened ecosystems and species in the African forest zone.

P10 - Analysis on three key issues of constant continuous forestry (CCF)

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The constant continuous forestry (CCF) is still not utilized widely though it has a 100-year history. The three major issues and questions regarding the suitability of CFF are: "Where is enough suitable land for operating CCF? What is the ideal stand structure of CCF? Is CCF economically efficient?” This paper analyses these three key issues and makes suggestions. A multifunctional forest-site-evaluation index was developed to determine the suitable areas for CCF. We created a utility function to determine objectives for forest and developed a cost-benefit analysis model to evaluate the CCF.

Keywords：CCF, Multi-functional forestry, Close-natural forestry, Key Issues

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List of Authors